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OLD WEST REGIONAL COMMISSION
QUARTERLY REPORT

October 1, 1975 to December 31, 1975
Project Number 10470022

A Study to Evaluate Potential Physical, Biological, and Water Use Impacts of Water Withdrawals and Water Development on the Middle and Lower Portions of the Yellowstone River Drainage in Montana.

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Project Coordinator
Old West Regional Commission
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Billings, Montana 59102

January 15, 1976

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INTRODUCTION

The purpose of this and previous quarterly reports is to demonstrate progress on the project. Information contained here is public and therefore available for use by others. It is preliminary, however, and must not be cited without specific permission from the Department of Natural Resources and Conservation.

There are no discrepancies between the terms of the contract and the work performed.

TASK 1. INVESTIGATION OF AQUATIC COMMUNITIES. This task entails particular attention to the habitats of the Tongue River Basin. The Grantee shall inventory and investigate the life history of aquatic invertebrates and forage fish which support major fish populations in the lower and middle Yellowstone.

AQUATIC INVERTEBRATE STUDIES

ACTIVITIES DURING THE QUARTER

Six Water's round bottom samples were taken at each of 10 stations along the entire Yellowstone River during October and November. No samples were taken at the lower river stations (Miles City, Glendive, Intake, and Sidney) in December because of ice conditions.

In addition, the Glendive and Intake sampling stations were vigorously sampled in an attempt to determine current and depth requirements for the important species. A total of 24 square-foot samples were taken at each of these stations during October and November. Some samples have been analyzed and some patterns are apparent. Generally invertebrate density increases with increasing current while diversity does not change. Distributional patterns for depth are not yet apparent. Some species have very marked current requirements; e.g. Plecoptera are only found in the fastest currents. Trichoptera larvae also prefer fast currents, and larvae of Hydropsyche and Cheumatopsyche show a definite preference for faster currents. Ephemeroptera nymphs illustrate a wide variation in current preference. Tricorythodes nymphs were found only along the shoreline where current was slow or non-existent. Choroterpes and Traverella seem to prefer moderate currents, and Baetis, Dactylobaetis and Rhithrogena prefer faster currents.

Arrangements were made with the Data Processing Division, Montana Department of Administration, to analyze the current-depth studies using regression and multiple regression analyses. Species diversity indices will also be calculated for these samples, as well as for the regular monthly samples. In an attempt to mathematically describe each sampling station, the computer is also calculating ordination values (Pielou 1969), which have been little used in aquatic biology but offer an alternative to long species lists and species diversity indices in describing the species composition of a station as this composition changes over a gradient or over a period of time.

Identification of species continued during the quarter. No changes in the Plecoptera list or distributions were made, and it appears that the species composition of this group in the river is completely known.

Trichoptera identification continued on adults captured during the summer. The species list now contains 35 species and about 95% of the river's known

genera. This group is dominated by the genera Hydropsyche (4 species) and Cheumatopsyche (5 species). About 95% of the captured species have been identified. The majority of species are not confined to the upper river, as in the Plecoptera; instead, there is a gradual change in species composition moving downstream. The lower river contains the fewest species.

Very few changes have been made to the Ephemeroptera species list during this quarter. New additions include Pseudocloeon, Centroptilum, Paraleptophlebia bicornuta and a second, unknown species of Tricorythodes. Distribution data were modified for several species; e.g. Dactylobaetis , Traverella, and Choroterpes have now been found as far upstream as Duck Creek Bridge.

Identification of species of the remaining orders has been successfully completed for the Odonata, Hemiptera, Coleoptera, Mollusca and Oligochaeta. Work is continuing with the difficult Diptera family Chironomidae.

Bottom samples were collected on the Tongue River and have been sent to technicians for picking.

ACTIVITIES FOR NEXT QUARTER

During the next quarter, all bottom samples should be picked, counted, and identified. Data analysis should be completed or nearly so. Species identifications will continue and should be nearing completion. If insects can be captured from the river during these severe ice conditions, an attempt will be made to determine exact current requirements utilizing equipment at the federal fish hatchery in Miles City. Collections will be made of winter emerging insects and emergence lists will be constructed for all insects.

FORAGE FISH INVESTIGATIONS

Forage fish samples were taken in the vicinities of Forsyth, Miles City, and Glendive during the fall of 1974 using a 50' x 6' x 1/4" mesh bag seine in both backwater and main channel areas. During the fall of 1975 more extensive forage fish samples were taken at seven locations on the lower river: Hysham, Forsyth, Miles City, mouth of Powder River, Terry, Intake, and Sidney. These samples were taken in both main-channel and backwater areas, using a 100' x 8' x 1/4" loose-hung seine.

Seventeen species have been tentatively identified from the samples taken during the fall of 1975. Species and collection sites are shown in table 1. Samples taken during 1974 are presently being identified.

To determine the importance of specific forage species, food habit studies are being conducted on a variety of piscivorous species including sauger, walleye, channel catfish, burbot, and goldeye. Stomach samples have been and will continue to be taken from these species and will be examined when time permits.

TABLE 1. Tentative species list, Fall, 1975 Yellowstone River Forage Fish Study.

Location & Day	Species	
9-29-75 Across from Hysham Backwater in Main Channel.	Flathead chub	(*Hybopsis gracilis*)
	Lake chub	(*Couesius plumbeus*)
	White sucker	(*Catostomus commersoni*)
	Mountain sucker	(*Catostomus platyrhynchus*)
9-29-75 Hysham Backwater	Carp	(*Cyprinus carpio*)
	Emerald shiner	(*Notropis atherinoides*)
	River carpsucker	(*Carpiodes carpio*)
	White sucker	(*Catostomus commersoni*)
	Mountain sucker	(*Catostomus platyrhynchus*)
9-29-75 Below Forsyth in Main Channel	Emerald shiner	(*Notropis atherinoides*)
	Silvery minnow	(*Hybognathus nuchalis*)
9-29-75 Below Forsyth in Backwater	Carp	(*Cyrinus carpio*)
	Flathead chub	(*Hybopsis gracilis*)
	Emerald shiner	(*Notropis atherinoides*)
	Silvery minnow	(*Hybognathus nuchalis*)
	Fathead minnow	(*Pimephales promelas*)
	River carpsucker	(*Carpiodes carpio*)
	White sucker	(*Catostomus commersoni*)
	Mountain sucker	(*Catostomus platyrhynchus*)
	Green sunfish	(*Lepomis cyanellus*)
9-30-75 Below Terry in Main Channel	Flathead chub	(*Hybopsis gracilis*)
	Emerald shiner	(*Notropis atherinoides*)
	Silvery minnow	(*Hybognathus nuchalis*)
9-30-75 Below Terry in Backwater	Goldeye	(*Hiodon alosoides*)
	Flathead chub	(*Hybopsis gracilis*)
	Emerald shiner	(*Notropis atherinoides*)
	Sand shiner	(*Notropis stramineus*)

TABLE 1 (continued)

Location & Day		Species	
		Fathead minnow	(*Pimephales promelas*)
		Shorthead redhorse	(*Moxostoma macrolepidotum*)
		Green sunfish	(*Lepomis cyanellus*)
		White crappie	(*Pomoxis annularis*)
		Black crappie	(*Pomoxis nigromaculatus*)
		Sauger	(*Stizostedion canadense*)
9-30-75	Below Powder River Main Channel, plus fish from puddles along side of river.	Flathead chub	(*Hybopsis gracilis*)
		Fathead minnow	(*Pimephales promelas*)
10-1-75	Cheyenne Island Backwater	Goldeye	(*Hiodon alosoides*)
		Carp	(*Cyprinus carpio*)
		Flathead chub	(*Hybopsis gracilis*)
		Emerald shiner	(*Notropis atherinoides*)
		Silvery minnow	(*Hybognathus nuchalis*)
		Fathead minnow	(*Pimephales promelas*)
		River carpsucker	(*Carpiodes carpio*)
		White sucker	(*Catostomus commersoni*)
		Green sunfish	(*Lepomis cyanellus*)
		Black crappie	(*Pomoxis nigromaculatus*)
10-3-75	Intake Main Channel.	Goldeye	(*Hiodon alosoides*)
		Finescale dace	(*Phoxinus neogaeus*)
		Flathead chub	(*Hybopsis gracilis*)
		Plains minnow	(*Hybognathus placitus*)
		Silvery minnow	(*Hybognathus nuchalis*)
		Emerald shiner	(*Notropis atherinoides*)
		River carpsucker	(*Carpiodes carpio*)
		Green sunfish	(*Lepomis cyanellus*)
		White crappie	(*Pomoxis annularis*)
10-3-75	Intake Backwater.	Flathead chub	(*Hybopsis gracilis*)
		Sturgeon chub	(*Hybopsis gelida*)
		Plains minnow	(*Hybognathus placitus*)
		Silvery minnow	(*Hybognathus nuchalis*)
		Emerald shiner	(*Notropis atherinoides*)
		White sucker	(*Catostomus commersoni*)

TABLE 1 (continued)

Location and Day	Species	
10-3-75 Sidney Main Channel	Flathead chub	(*Hybopsis gracilis*)
	Sturgeon chub	(*Hybopsis gelida*)
	Fathead minnow	(*Pimephales promelas*)
	Silvery minnow	(*Hybognathus nuchalis*)
	River carpsucker	(*Carpiodes carpio*)
	White crappie	(*Pomoxis annularis*)
10-3-75 Sidney Backwater	Goldeye	(*Hiodon alosoides*)
	Flathead chub	(*Hybopsis gracilis*)
	Emerald shiner	(*Notropis atherinoides*)
	Silvery minnow	(*Hybognathus nuchalis*)
	Fathead minnow	(*Pimephales promelas*)
	River carpsucker	(*Carpiodes carpio*)
	White crappie	(*Pomoxis annularis*)
10-29-75 Yellowstone River at Sidney	Goldeye	(*Hiodon alosoides*)
	Carp	(*Cyprinus carpio*)
	Flathead chub	(*Hybopsis gracilis*)
	Emerald shiner	(*Notropis atherinoides*)
	Plains minnow	(*Hybognathus placitus*)
	Silvery minnow	(*Hybognathus nuchalis*)
	Fathead minnow	(*Pimephales promelas*)
	River carpsucker	(*Carpiodes carpio*)
	Sauger	(*Stizostedion canadense*)
	Walleye	(*Stizostedion vitreum*)
10-30-75 Yellowstone River at Sidney	Sturgeon chub	(*Hybopsis gelida*)

TONGUE RIVER FISH STUDIES

TONGUE RIVER

Activities this quarter concentrated on four areas: 1) the completion of trapping and tagging catfish, 2) surveying three sections of river for the Water Surface Profile Program (W.S.P.), 3) comparison of methods for estimating population, and 4) evaluation of diversities on the fall electrofishing samples.

Catfish

Baited traps, constructed from reinforcing bar material and chicken wire, were utilized to sample channel catfish in three sections of the Tongue River. A total of 472 channel catfish were captured in 106 traps, a catch rate of 4.45 fish per trap. Catch rates per section were: Fort Keogh (Section Ib), 4.70 fish per trap (349 in 74 trap sets); Orcutt's (Section IIa), 2.00 fish per trap (24 in 12 trap sets); and S-H (Section IIb), 4.95 fish per trap (99 in 20 trap sets). Sections are shown in figure 1.

Catfish were tagged, weighed, measured, and released. The average lengths and weights per section were: Fort Keogh--15.8 inches and 1.53 pounds; Orcutt's--19.4 inches and 2.8 pounds; S-H--17.8 inches and 2.35 pounds. Baited traps are fairly selective in their catch. The percentage of catfish per section was: Fort Keogh--82.7%; Orcutt's--77.4%; S-H--91.6%; total--84.1%. Other abundant species captured were shorthead redhorse, goldeye, sauger, and softshell turtles. The sauger and softshell turtles were weighed, measured, and tagged with numbered spaghetti tags. Other fish were counted and released.

Correlation coefficients (a measure, expressed as r, of the degree of closeness to a linear relationship between two variables) between the catch per trap and the maximum temperature, minimum temperature, and discharge were calculated. The values are shown in table 2; it can be seen that temperature plays a definite fole in the catch rate of the traps while discharge is a factor which should not be weighted as heavily.

TABLE 2. Comparison of the catch per trap with maximum temperature, minimum temperature, and discharge using correlation coefficients.

	Correlation Coefficient
Catch per trap and maximum temperature	.519
Catch per trap and minimum temperature	.589
Catch per trap and discharge	.441

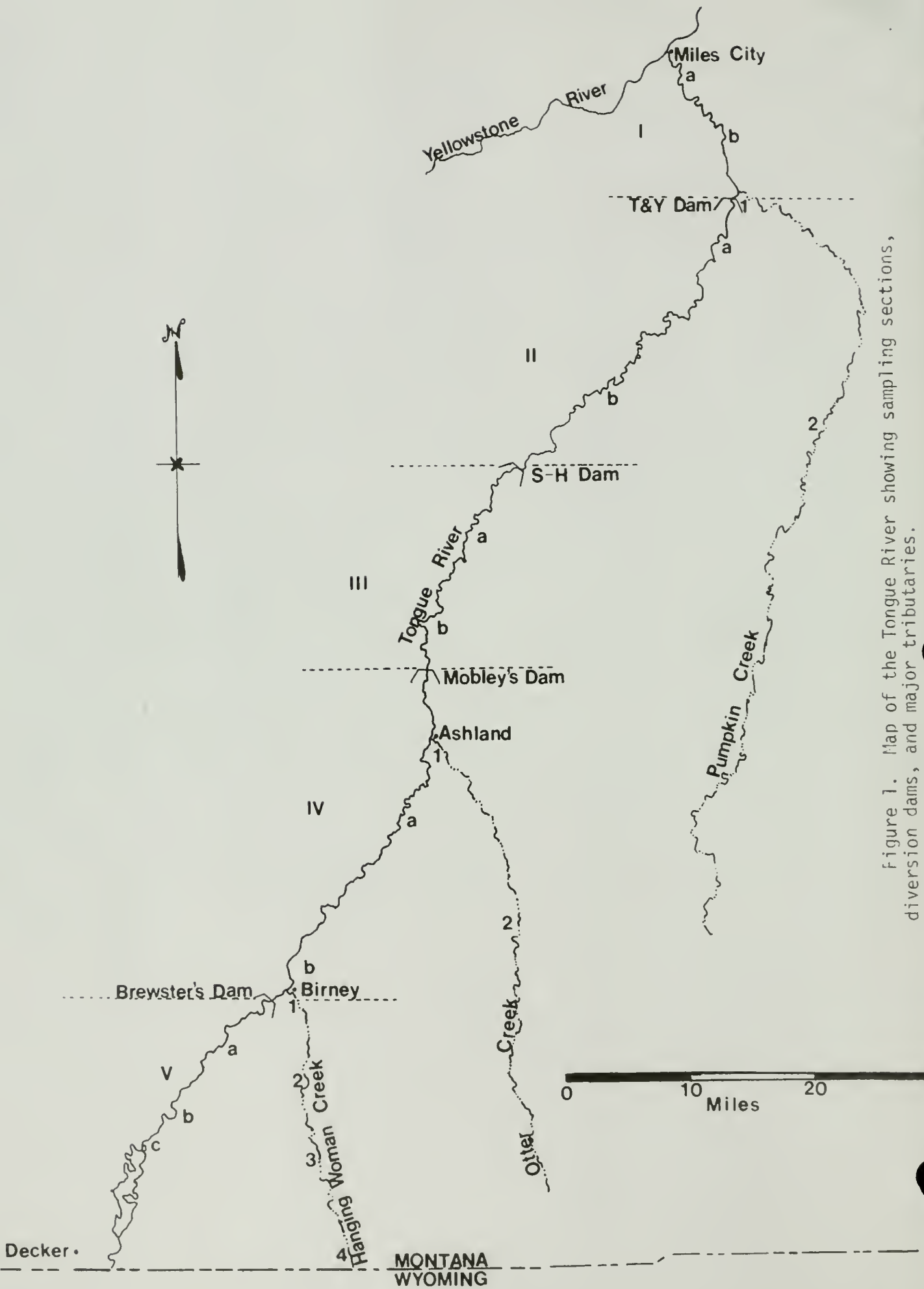

Figure 1. Map of the Tongue River showing sampling sections, diversion dams, and major tributaries.

Water Surface Profiles

Three primary and one secondary sampling sections were surveyed for the Bureau of Reclamation Water Surface Profile Program. They were: Fort Keogh (Section Ib), S-H (Section IIb), and Birney (Section IVb) as primary and Viall's (Section IIIa) as secondary.

During the dewatering of the Tongue River, water surface elevations were obtained at the S-H Section as a check on the program (table 3). A non-parametric, two-tailed significance test (Wilcoxon) was run between actual and program water surface elevations. No significant difference was detected at the 80 percent level ($p > .20$). The greatest difference at any transect was 0.11 feet with an average deviation of 0.004 feet and an average absolute deviation of 0.04 feet.

TABLE 3. Actual and program water surface elevations at S-H Section with 100 CFS flow.

	Transect						
	1	2	3	4	5	6	7
Program	992.98	993.37	993.42	993.50	993.58	993.66	993.73
Actual	993.09	993.39	993.41	993.57	993.57	993.61	993.64
Absolute Deviation	.11	.02	.01	.01	.01	.05	.09

The following physical characteristics will be obtained for selected flows at each section.

1) pool-riffle periodicity
2) hydraulic radius
3) sinuosity
4) average velocity
5) depth
6) wetted perimeter

Estimates of stream conditions obtained from the program will be used to evaluate instream flow needs on the Tongue River. Flow requirements for passage, spawning, and rearing will be considered.

Methods for Estimating Population

Problems encountered in obtaining an accurate estimate of fish populations in the Tongue River prompted an evaluation of population estimating methods. A Petersen mark-recapture method (Robson and Regier 1964; Ricker 1958) is difficult to use because the sample of marked fish must be large. The modified

Schnabel method (Ricker 1958, Chapman and Overton 1966) requires continued addition of marked fish.

The DeLuey (Ricker 1958, Johnson 1965), Leslie (Ricker 1958) and two-catch methods (Seber and Cren 1967) were therefore investigated for their possible use on the Tongue River and its tributaries. In each of these methods a sizable portion (>50%) of the population must be removed or marked.

If time permits, these methods will be tested next spring on the tributaries.

Species Diversity

Fish population diversities were calculated on the fall sampling of 4 primary sections. They were: Fort Keogh (Section Ib); S-H (Section IIb); Birney (Section IVb); Dam (Section Vc).

Shannon diversity indices were calculated for the fall 1975 sample and the combined sample of fall 1974 and fall 1975 (figure 2). The fall 1974 sample diversities were also plotted for comparison, but Sections IIIa and Vb were omitted because they were not sampled in 1975. With the inclusion of more data the diversity indices theoretically tend to the true population diversity, assuming no drastic change over time. In comparing the data, the major difference lies in Section Vc, where the index rise was attributed to a change in the number of fish per mile (231 to 292) and a gain in the number of species (11 to 15). The probable reasons for these gains are two-fold: 1) Prolonged high releases from the reservoir this summer are not characteristic of past flows and favor certain species over others from both flow and temperature standpoints; 2) Inspections and drawdowns may have influenced the distribution patterns. The remaining sections had little change.

TONGUE RIVER RESERVOIR

Most work on the Tongue River Reservoir was suspended during the quarter because of extreme drawdown and icing.

ACTIVITIES ANTICIPATED NEXT QUARTER

For the Tongue River, evaluation of fall sampling data will continue, and water surface profile data will be analyzed. Creel census data from the reservoir will be summarized, and data will be gathered on winter fishing pressure and harvest.

Task 1 is about 65% completed.

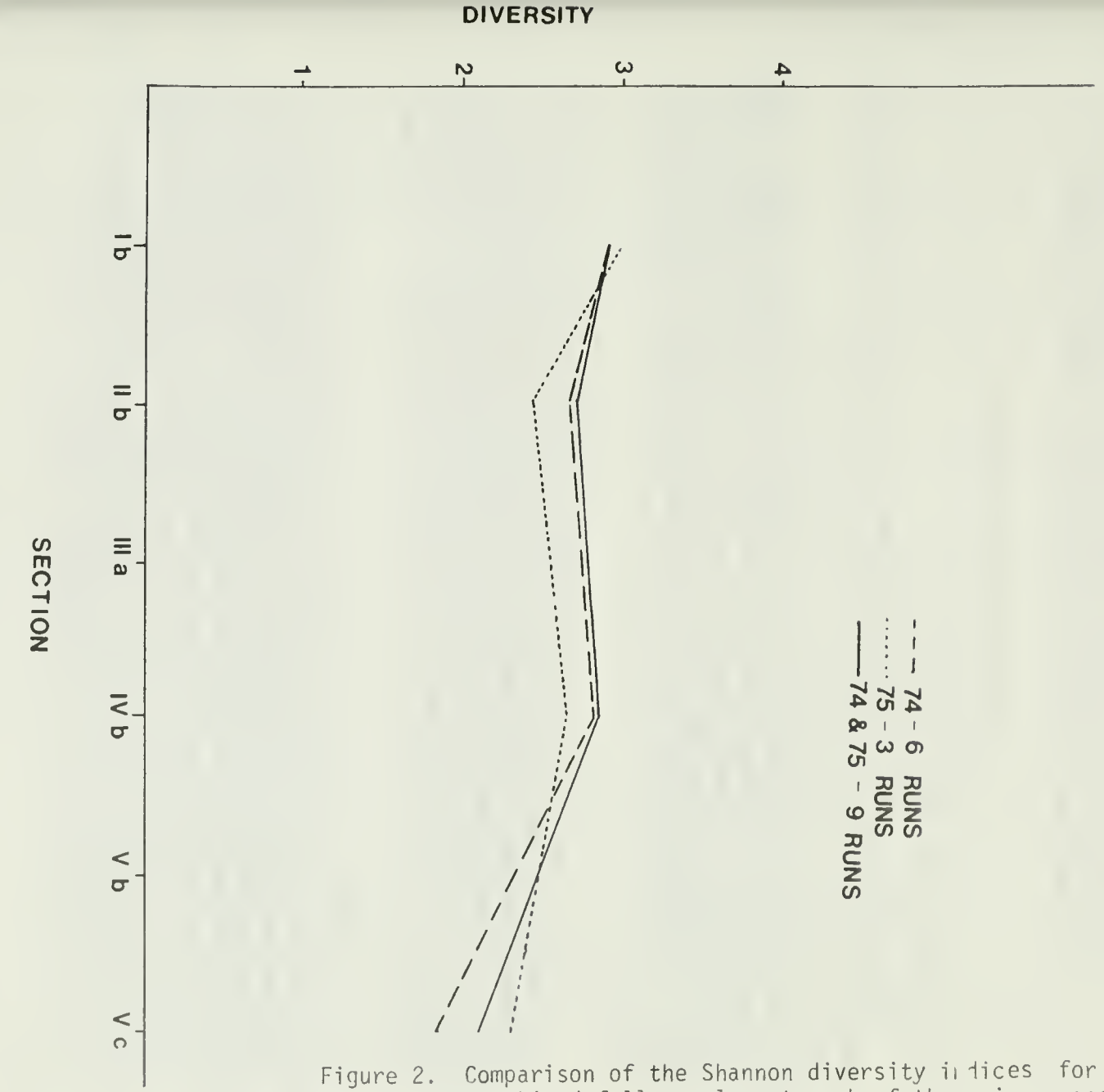

Figure 2. Comparison of the Shannon diversity indices for 1974-1975 fall sampling and the combined fall samples at each of the primary sections on the Tongue River.

TASK 2. ASSESSMENT OF THE IMPACT OF ALTERED STREAM FLOWS ON SELECTED MIGRATORY BIRDS. The Grantee shall make a complete analysis of the structure and vegetation of the Yellowstone River from Big Timber to the North Dakota border, with major emphasis being placed upon the islands. The Grantee shall determine the importance of the river system, and altered stream flows, to migratory birds, including but not limited to geese, ducks, bald eagles, and great blue herons. The Grantee shall assess the ecological productivity and importance of this river system from a regional perspective.

ACTIVITIES DURING THE QUARTER

FIELD-FEEDING WATER FOWL OBSERVATIONS

Observations of field-feeding waterfowl were continued this quarter to supplement similar data collected in 1974. Once compiled, these data will be used to determine crop preferences of field-feeding species.

Although field-feeding observations compiled this quarter reflect those recorded in 1974, preference for a particular field appeared to affect overall crop preferences. However, geese and to a lesser degree field-feeding ducks were not observed to use the same fields to the same extent during the two years. The Hammond Valley west of Forsyth was an exception, however, as it provided feeding areas for the largest concentrations of ducks and geese in both years.

Because large numbers of field-feeding ducks were present in the study area for only a short period during the quarter, it was difficult to sample a significant number of field-feeding mallards for sex ratio determination. However, in the Hammond Valley, where the largest field-feeding duck populations occurred, a sample of 1,858 mallards produced a sex ratio of 62.5 males to 100 females. This is similar to the 63.0 males to 100 females estimated there in 1974.

AERIAL CENSUSES

Aerial censuses of migratory birds were conducted regularly until early December when duck and goose populations decreased to wintering levels (table 4), apparently as a result of subzero weather and heavy snow which occurred in the study area the last week in November. Ospreys, great blue herons, and cormorants were present in the area only during early fall. Ospreys occur only as fall migrants, and herons and cormorants, resident throughout the summer, leave with the onset of colder weather. Goldeneyes do not appear until cold weather sets in, at which time the number of bald eagles present also noticeably increases. The common merganser population in the study area varies in size throughout the year, but generally increases in late fall.

TABLE 4. Aerial censuses of selected migratory birds along the lower Yellowstone River between Billings and Fairview, Montana during 1975.

Date	Canada Geese	Dabbling Ducks	Great Blue Herons	Double-Crested Cormorants	Ospreys	Common Mergansers	Imm. Bald Eagles	Adult Bald Eagles	Common Goldeneyes
10/ 2 & 3	2,329	741	46	27	1	101	1	0	0
10/ 9 & 10	2,753	1,853	15	22	2	36	2	2	0
10/23 & 24	2,727	10,201	1	3	0	7	4	3	0
11/ 4 & 5	1,625	6,384	2	0	0	55	1	3	6
11/12 & 13	6,514	33,067	0	0	0	43	5	10	65
11/19 & 20	9,949	46,439	0	0	0	88	3	29	623
12/ 3 & 5	369	6,095	0	0	0	347	10	47	1,616

The duck and goose population estimates obtained from the aerial censuses were summarized and graphed in comparison to 1974 figures. Goose observations were also plotted on maps to show possible distribution changes resulting from the altered waterfowl hunting closures implemented in 1975. In 1975, duck and goose numbers increased more rapidly and to higher peaks than in 1974, but the populations decreased sooner to wintering levels due to inclement weather in late November.

OTHER ACTIVITIES THIS QUARTER

National Weather Service maps were obtained from the Federal Aviation Administration office in Miles City in an attempt to correlate observed bird migrations through the lower Yellowstone Valley with changing weather patterns. However, the cost of obtaining a complete set of 850 millibar maps and weather summaries for the periods of the study during which major migrations occurred seemed unwarranted considering the nature of information to be obtained from this work.

Band returns obtained during the quarter indicated use of the valley by migrant waterfowl banded in northeastern Montana, northern and eastern Colorado, Oregon, and southeastern New Mexico. Many of these migration corridors have been delineated by Bellrose (1968). In addition, some direct recoveries were obtained from geese banded in the study area in 1975. Two geese were recovered which had been leg- and neck-banded but on which no neck bands were present at the time the birds were shot.

Three drake common mergansers and two drake common goldeneyes were collected

for food habits analyses. Stomach contents showed the piscivorous feeding habits of the mergansers and the insectivorous and herbivorous feeding habits of the goldeneyes. Final analyses of these species' food habits will depend on future bird collections.

Hunters were contacted during the quarter to obtain reports of direct recoveries of neck-banded geese. Seven such recoveries were reported. Hunters contacted also reported leg bands which were sent to the Patuxent Wildlife Research Center, Laurel, Maryland, to determine migration patterns of birds stopping in the study area. Hunters were also questioned as to where they had observed neck-banded geese, although even those hunters bagging neck-banded geese did not realize they were marked until they had the birds in hand. Hunters were also questioned regarding their observations of field-feeding waterfowl hunting areas for the 1975-76 season.

Also this quarter, plans were begun to measure island and riverbank vegetation and physical parameters from aerial photographs. Data tabulation for the final report was begun. Field-feeding and river observations of some of the less common species were tabulated.

ACTIVITIES DURING THE NEXT QUARTER

During the upcoming quarter the following activities are planned: analysis of data to determine possible impacts of water withdrawals on migratory bird populations; vegetational analysis from aerial photographs; and mid-winter aerial censuses.

Task 2 is approximately 60% completed.

TASK 3. ASSESSMENT OF THE IMPACT OF ALTERED STREAM FLOWS ON SELECTED FURBEARING MAMMALS. The Grantee shall inventory furbearing mammals along the Yellowstone River from Big Timber to the North Dakota border and determine their relative abundance. The Grantee shall identify the habitat types most important to selected species, including but not limited to beaver, muskrat, mink, and river otter, and assess the impacts of seasonally altered streamflows in each species. The Grantee shall assess related impacts on the supplemental income of individuals engaged in the trapping and sale of these animals.

INVENTORY OF ANIMALS

The annual beaver cache survey was completed during this quarter. The Yellowstone River from Big Timber to the North Dakota border, the Tongue River from its mouth to the Tongue River Reservoir, and the Bighorn River from its mouth to the Yellowtail afterbay dam were flown, a total of approximately 713 river miles (tables 5, 6, and 7).

Caches were plotted on work maps for comparison with last year's count. Several statements concerning the data (tables 8, 9, and 10) can be made. Substantial gains in the beaver population were made in all 3 streams but the rankings were unchanged. The Yellowstone River mainstem, which is in a nearly natural state, apparently is better suited to beaver than either the Tongue or Bighorn rivers, both of which have major impoundments. Caches per mile for the 3 rivers were 1.45, 1.01 and 0.88, respectively.

Some counts were seemingly made too early in 1974. For instance, all of the sections of the Yellowstone counted prior to October 28, 1974 registered increases of over 100% in 1975. The only section of the Tongue River with over 100% increase was counted before October 25. Nevertheless, that there was a real increase is shown in that all but 3 of the 22 sections had more caches in 1975.

Rankings of beaver density within river systems were generally unchanged (figure 3). On the Yellowstone, the same 2 sections were highest both years. Likewise, the same 2 were lowest. Sections 6 and 7, the 2 earliest counted in 1974, retained their relationship to each other and climbed from 7th and 9th to 3rd and 4th ranking, respectively. Sections 3, 10 and 11, all counted later than October 28 both years, retained their positions relative to each other but slipped from the 3, 5, and 6 positions to 7, 8, and 9, respectively. Section 5, counted too early in 1974, rose from 8th to 6th rank. Section 9 fell from 4th to 5th. On both the Bighorn and Tongue rivers the section immediately downstream from the impoundment had the lowest beaver densities in 1975.

TABLE 5. Beaver caches on the Yellowstone River--1975

Section	Length 1/	Caches (2/)	Caches/mile	Miles/cache	Date Flown
North Dakota border to Shadwell Cr	45.2	24 (23)	0.53	1.88	10/31
Shadwell to Morgan Cr	31.1	69 (63)	2.22	0.45	10/31
Morgan to Hatchet Cr	45.9	67 (48)	1.46	0.69	10/30 and 10/31
Hatchet Cr to Tongue River	62.8	35 (32)	0.56	1.79	10/30
Tongue River to Rosebud Cr	39.5	59 (57)	1.49	0.67	10/30
Rosebud to Froze-to-Death Cr	45.4	88 (87)	1.94	0.52	10/28 and 11/6
Froze-to-Death Cr to Bighorn River	25.7	47 (47)	1.83	0.55	11/6
Bighorn River to Pompey's Pillar Cr	32.9	80 (79)	2.43	0.41	11/6
Pompey's Pillar to Alkali Cr	31.5	50 (50)	1.59	0.63	11/6
Alkali Cr to Stillwater River	53.1	64 (64)	1.21	0.83	11/12
Stillwater to Boulder River	42.9	55 (55)	1.28	0.78	11/12
Total	456	638 (605)	1.40	.72	

1/ Length in miles

2/ Caches with associated data presented in Table 11.

TABLE 6. Beaver caches on the Tongue River--1975

Section	Length 1/	Caches (2/)	Caches/mile	Miles/cache	Date Flown
Mouth to Circle L Cr	28.2	27 (27)	0.96	1.04	11/3
Circle L to Horse Cr	25.5	25 (24)	0.98	1.02	11/3
Horse to Hart Cr	28.4	24 (22)	0.85	1.18	11/3
Hart Cr to Spring Cr	37.1	44 (42)	1.19	0.84	11/3 and 11/5
Spring Cr to Brown's Gulch	34.7	41 (39)	1.18	0.85	11/5
Brown's Gulch to Deadman's Gulch	16.2	16 (16)	0.99	1.01	11/5
Deadman's Gulch Tongue River Dam	19.0	14 (13)	0.74	1.36	11/5
Total	189.1	191 (183)	1.01	0.99	

1/ Length in miles

2/ Caches with associated data presented in Table 12.

TABLE 7. Beaver caches on the Bighorn River--1975.

Section	Length 1/	Caches (2/)	Caches/mile	Mile/cache	Date Flown
Mouth to Pocket Cr	18.1	16 (16)	0.88	1.13	11/7
Pocket Cr to Little Bighorn River	24.5	28 (28)	1.14	0.88	11/7
Little Bighorn to St. Xavier Bridge	25.2	23 (22)	0.91	1.10	11/7
St. Xavier Bridge to Yellowtail Afterbay	16.5	7 (7)	0.42	2.36	11/7
Total	84.3	74 (73)	.88	1.14	

1/ Length in miles

2/ Caches with associated data presented in Table 13.

TABLE 8. Beaver cache count comparison between 1974 and 1975 on the Yellowstone River

Section 1/	1974 Date	1974 Number	1974 Caches/ Mile	1975 Date	1975 Number	1975 Caches/ Mile	Change in Numbers	Percent
1	10/29	18	0.40	10/31	24	0.53	+ 6	33
2	10/29	76	2.44	10/31	69	2.22	- 7	9
3	10/29	59	1.29	10/30 and 10/31	67	1.46	+ 8	14
4	10/25	16	0.25	10/30	35	0.56	+19	119
5	10/18	29	0.73	10/30	59	1.49	+30	103
6	10/8	40	0.88	10/28 and 11/6	88	1.94	+44	110
7	10/9	15	0.58	11/6	47	1.83	+32	213
8	11/7	74	2.25	11/6	80	2.43	+ 6	8
9	11/7	34	1.08	11/6	50	1.59	+16	47
10	11/14	53	1.00	11/12	64	1.21	+11	21
11	11/15	46	1.07	11/12	55	1.28	+ 9	20
Total		460	1.01		638	1.40	+178	39

1/ Description of section in Table 5.

TABLE 9. Beaver cache count comparison between 1974 and 1975 on the Tongue River

Section 1/	1974 Date	1974 Number	1974 Caches / Mile	1975 Date	1975 Number	1975 Caches / Mile	Change in Number	Percent
1	10/18 & 24	11	0.39	11/3	27	0.96	+16	145
2	10/24	15	0.59	11/3	25	0.98	+10	67
3	10/24	22	0.77	11/3	24	0.85	+ 2	9
4	10/24 & 11/6	32	0.86	11/3 & 5	44	1.19	+12	38
5	11/6	25	0.72	11/5	41	1.18	+16	64
6	11/6	17	1.05	11/5	16	0.99	- 1	6
7	11/6	10	0.53	11/5	14	0.74	+ 4	40
Total		132	0.70		191	1.01	+59	45

1/ Description of sections in Table 6.

TABLE 10. Beaver cache count comparison between 1974 and 1975 on the Bighorn River.

Section	1974 Date	1974 Number	1974 Caches / Mile	1975 Date	1975 Number	1975 Caches Mile	Change in Number	Percent
1	11/4	16	0.88	11/7	16	0.88	0	0
2	11/4	16	0.65	11/7	28	1.14	+12	75
3	11/5	9	0.36	11/7	23	0.91	+14	156
4	11/5	6	0.36	11/7	7	0.42	+ 1	17
		47	0.56		74	0.88	+27	57

1/ Description of sections in Table 7.

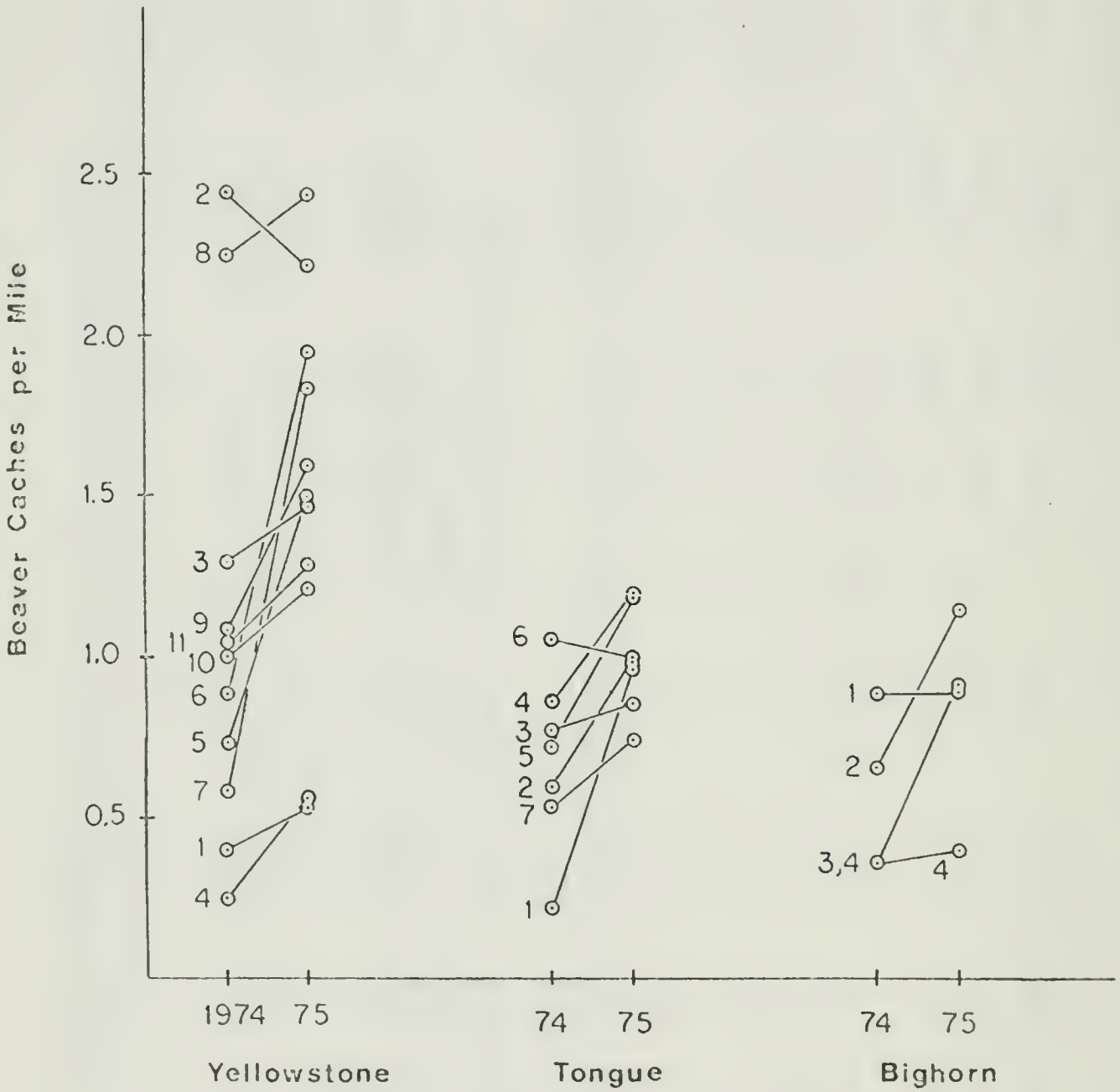

Figure 3. Beaver densities by section of the Yellowstone, Tongue and Bighorn Rivers in 1974 and 1975. See Tables 1-3 for section descriptions.

During the beaver cache survey, cache location, river morphology, bank vegetation, and primary cache vegetation were recorded for most of the observed caches (tables 11, 12, and 13). Cache location was recorded as being either onstream--1) mainland--2) island-or offstream--3) manmade, or 4) natural. River morphology was categorized into three classes: 1) braided--more than two water channels, 2) split--two water channels, and 3) straight--one water channel. Bank vegetation was described as 1) pure willow, 2) pure cottonwood, 3) mixed willow and cottonwood, and 4) other. Vegetation in the cache was broken into two categories: 1) willow and 2) other.

Practically all caches were composed of willow: 100%, 99%, and 97% on the Yellowstone, Tongue, and Bighorn, respectively. Most of the caches were found at onstream locations: 88%, 94%, and 89% for the Yellowstone, Tongue, and Bighorn, respectively. As expected, willow was the most common bank vegetation in all three systems. Willow and willow-cottonwood accounted for 93%, 81%, and 88% of the bank vegetation in the 3 streams. Only in river morphology was any real difference noted among the three rivers. On the Yellowstone and Bighorn rivers only 13% and 15%, respectively, of the caches were located in straight channel situations. Seventy-nine percent of the caches on the Tongue River were located on straight channels. The reason for this dissimilarity is simply that the Tongue River has few split channels and practically no braided channels.

Beaver, mink, and muskrat harvest parameters (numbers trapped, total number of trappers, average catch per trapper, and average pelt price) for Fish and Game Regions 5 and 7 and state-wide covering the fourteen-year period from 1960-61 through 1973-74 are given in tables 14, 15, 16, and 17. Statistical analysis of these data have not been completed at this time. Line graphs depicting yearly harvest trends will be included in the next quarterly report.

HABITAT TYPES

No work was done in this area.

EFFECT OF TRAPPING ON INCOME

Average dollars per trapper per species and total dollars realized from the sale of pelts for Fish and Game Regions 5 and 7 for the 1973-74 trapping season are shown in table 18.

IMPACT OF ALTERED STREAMFLOWS

Histographs depicting the shift toward smaller islands and gravel bars on the Bighorn River from 1939 to 1974 were begun.

TABLE 11. Parameters of observed caches on the Yellowstone River expressed as percentages

Section 1/	Caches Observed	Location: Onstream Mainland	Location: Onstream Island	Location: Offstream Manmade	Location: Offstream Natural	River Morphology: Braided	River Morphology: Split	River Morphology: Straight	Bank Vegetation: Willow	Bank Vegetation: Cottonwood	Bank Vegetation: Willow and Cottonwood	Bank Vegetation: Other	Cache Vegetation: Willow	Cache Vegetation: Other
1	96	61	22	9	9	74	4	4	30	4	65	0	100	0
2	91	52	28	4	7	57	19	4	23	1	64	3	100	0
3	72	54	40	0	6	48	27	19	71	2	25	2	98	2
4	91	22	50	0	28	9	22	41	88	0	6	6	100	0
5	97	53	37	7	4	26	36	28	37	4	53	7	98	2
6	99	52	39	7	2	60	24	7	36	1	52	11	100	0
7	100	60	38	0	2	62	28	9	36	0	53	11	100	0
8	99	61	34	1	4	65	24	6	39	0	59	1	100	0
9	100	58	32	0	10	36	50	4	32	2	56	10	100	0
10	100	48	41	0	11	34	38	17	41	6	52	2	100	0
11	100	45	24	7	24	22	36	11	51	0	49	0	100	0
Total	95	53	35	3	9	46	29	13	42	2	51	5	100	tr 2/

1/ Descriptions of sections in Table 5.

2/ tr= trace; a value less than .05 percent

TABLE 12. Parameters of observed caches on the Tongue River expressed as percentages

Section 1/	Caches Observed	Location				River Morphology			Bank Vegetation				Cache Vegetation	
		Onstream		Offstream										
		Mainland	Island	Man made	Natural	Braided	Split	Straight	Willow	Cottonwood	Willow and Cottonwood	Other	Willow	Other
1	100	4	89	0	7	0	11	81	37	4	30	30	96	4
2	96	13	79	0	8	0	25	67	33	4	50	13	100	0
3	92	9	86	0	5	0	14	82	36	0	55	9	100	0
4	95	2	95	0	2	2	12	83	17	7	67	10	98	2
5	95	8	85	3	5	0	15	77	28	3	51	18	100	0
6	100	6	94	0	0	0	13	88	44	0	44	13	100	0
7	93	15	77	0	8	0	15	77	62	15	15	8	100	0
Total	96	7	87	1	15	1	15	79	32	4	49	15	99	1

1/ Descriptions of sections in Table 6.

TABLE 13. Parameters of observed caches on the Bighorn River expressed as percentages

		Location				River Morphology			Bank Vegetation				Cache Vegetation	
		Onstream		Offstream										
Section 1/	Caches Observed	Mainland	Island	Man made	Natural	Braided	Split	Straight	Willow	Cottonwood	Willow and Cottonwood	Other	Willow	Other
1	100	50	44	0	6	50	25	19	50	6	44	0	94	6
2	100	43	50	0	7	46	29	18	36	0	46	18	100	0
3	96	68	18	0	14	32	9	36	55	9	36	0	95	5
4	100	43	29	0	29	29	14	29	71	0	14	14	100	0
Total	99	52	37	0	11	41	33	15	48	4	40	8	97	3

1/ Descriptions of sections in Table 7.

TABLE 14. Estimated numbers of beaver, mink, and muskrats trapped state-wide and in Fish and Game Regions 5 and 7

Season	Beaver			Mink			Muskrats		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	2800	1800	23,000	1048	206	8,700	2925	428	31,100
1961-62	2100	1300	16,000	839	170	6,400	4860	672	31,112
1962-63	2100	2100	22,000	1150	521	9,100	6642	1279	45,900
1963-64	915	599	16,000	1220	368	9,600	3366	1370	49,000
1964-65	714	294	7,800	797	154	5,800	2722	219	22,000
1965-66	533	1306	11,000	974	177	7,000	2495	516	39,800
1966-67	839	533	12,200	777	115	6,200	2047	130	33,100
1967-68	989	713	11,890	493	149	4,580	1245	422	19,610
1968-69	1059	818	12,405	390	192	5,750	1689	1330	31,245
1969-70	1619	922	14,135	641	168	8,070	2117	1256	44,270
1970-71	943	391	8,435	255	95	3,621	1296	501	22,453
1971-72	1005	641	10,030	213	60	3,158	1439	329	24,498
1972-73	1866	1888	15,612	249	233	4,041	2704	1657	34,075
1973-74	1946	996	13,162	346	209	4,029	3269	891	22,908

TABLE 15. Estimated number of beaver, mink, and muskrat trappers state-wide and in Fish and Game Regions 5 and 7

Season	Beaver			Mink			Muskrat		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	95	51	794	92	35	831	93	29	746
1961-62	91	66	707	94	34	765	108	28	689
1962-63	74	50	635	93	35	681	95	46	650
1963-64	65	47	695	100	38	857	92	44	848
1964-65	47	24	501	92	24	611	81	18	575
1965-66	38	40	536	99	26	625	73	20	625
1966-67	57	38	586	81	21	636	76	16	651
1967-68	66	36	670	73	24	594	68	29	623
1968-69	62	46	652	53	21	558	67	29	622
1969-70	87	56	850	81	27	770	98	41	897
1970-71	50	32	556	43	17	485	57	21	578
1971-72	68	35	622	50	18	451	65	24	597
1972-73	115	83	861	69	35	606	109	56	785
1973-74	131	87	997	75	51	738	131	54	890

TABLE 16. Average catch per trapper for beaver, mink, and muskrat state-wide and in Fish and Game Regions 5 and 7

Season	Beaver			Mink			Muskrat		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	34.3	33.1	30.0	11.4	5.9	10.5	31.4	14.8	41.7
1961-62	22.9	19.2	22.5	8.9	5.0	8.4	45.0	24.0	45.1
1962-63	28.5	43.0	34.6	12.4	14.9	13.4	69.9	27.8	70.6
1963-64	14.2	12.8	23.2	12.3	9.8	11.2	36.8	31.1	57.7
1964-65	14.9	12.1	15.6	8.5	6.4	9.5	33.2	12.3	39.1
1965-66	14.0	32.7	20.4	9.8	6.8	11.2	34.2	25.8	63.6
1966-67	14.7	14.0	20.9	9.6	5.5	9.7	26.9	8.1	50.8
1967-68	14.9	19.6	17.8	6.8	6.3	7.7	18.3	14.8	31.5
1968-69	17.2	18.4	19.0	7.4	9.2	10.3	25.1	45.6	50.3
1969-70	18.7	16.6	16.6	7.9	6.2	10.5	21.7	31.0	49.3
1970-71	18.9	12.2	15.0	6.0	5.5	7.5	22.7	23.5	38.9
1971-72	14.9	18.5	16.1	4.2	3.3	7.0	22.2	14.0	41.0
1972-73	16.2	22.6	18.1	3.6	6.7	6.7	24.7	29.5	43.4
1973-74	14.9	11.4	13.2	4.6	4.1	5.5	25.1	16.5	25.8

TABLE 17. Average pelt price for beaver, mink, and muskrat state-wide and in Fish and Game Regions 5 and 7

Season	Beaver			Mink			Muskrat		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	8.33[1]/	7.91	8.86	10.89	8.06	11.13	0.46	0.45	0.48
1961-62	7.89	7.31	8.21	8.78	13.18	9.34	0.76	0.83	0.77
1962-63	10.22	8.23	10.26	10.01	16.95	10.71	1.01	0.76	0.81
1963-64	8.52	9.23	10.18	13.57	15.82	12.38	0.89	0.80	0.98
1964-65	8.55	7.36	9.63	8.79	14.41	10.18	0.86	0.67	0.88
1965-66	9.48	10.29	11.54	9.92	15.18	10.23	1.07	1.24	1.16
1966-67	10.61	9.82	10.23	7.60	11.75	10.01	0.69	0.66	0.72
1967-68	11.63	10.55	10.67	6.66	9.36	9.12	0.40	0.54	0.68
1968-69	12.59	10.81	13.52	10.78	10.01	10.88	0.67	0.74	0.79
1969-70	10.60	9.55	11.00	5.68	9.88	8.33	0.90	0.88	0.95
1970-71	9.52	7.95	9.29	4.13	6.45	4.69	0.74	0.67	0.88
1971-72	12.47	12.78	12.69	5.02	9.79	6.03	1.07	1.06	1.31
1972-73	15.06	12.92	15.95	9.41	15.30	11.74	1.52	1.46	1.43
1973-74	14.47	14.62	15.95	10.29	16.74	14.46	2.00	1.56	1.98

1/ Dollars

TABLE 18. Total dollars per species and average dollars realized per trapper per species in Fish and Game Regions 5 and 7

Season	BEAVER				MINK				MUSKRAT			
	Region 5		Region 7		Region 5		Region 7		Region 5		Region 7	
	1/	2/	1	2	1	2	1	2	1	2	1	2
1960-61	23,324.00	285.72	14,239.00	261.82	11,412.72	124.15	1,660.36	47.55	1,345.50	14.44	192.60	6.66
1961-62	16,569.00	180.68	9,503.00	140.35	7,366.42	78.14	2,240.60	65.90	3,693.60	34.20	557.76	19.92
1962-63	21,462.00	291.27	17,283.00	353.89	11,511.50	124.12	8,830.95	252.56	6,708.42	70.60	972.04	21.13
1963-64	7,795.00	120.98	5,528.77	118.14	16,555.40	166.91	5,821.76	155.04	2,995.74	32.75	1,096.00	24.88
1964-65	6,104.70	127.40	2,163.84	89.06	7,005.63	74.72	2,219.14	92.22	2,340.92	28.55	146.73	8.24
1965-66	5,052.84	132.72	13,438.74	336.48	9,662.08	97.22	2,686.86	103.22	2,669.65	36.59	639.84	31.99
1966-67	8,901.79	155.97	5,234.06	137.48	5,905.20	72.96	1,351.25	64.63	1,412.43	18.56	85.80	5.35
1967-68	11,502.07	173.29	7,522.15	206.78	3,283.38	45.29	1,394.64	58.97	498.00	7.32	227.88	7.99
1968-69	13,332.81	216.55	8,924.38	198.90	4,204.20	79.77	1,921.92	92.09	1,131.63	16.82	984.20	33.74
1969-70	16,999.50	196.35	8,805.10	158.53	3,640.88	44.87	1,659.84	61.26	1,905.30	19.53	1,105.28	27.28
1970-71	8,977.36	179.93	3,108.45	96.99	1,053.15	24.78	612.75	35.48	959.04	16.80	335.67	15.75
1971-72	12,532.35	185.50	8,101.98	236.43	1,069.26	21.08	587.40	32.31	1,539.73	23.75	348.74	14.84
1972-73	28,101.96	243.97	24,392.96	291.99	2,343.09	33.88	3,564.90	102.51	4,110.08	37.54	2,419.22	43.07
1973-74	28,158.62	215.60	14,561.52	166.67	3,560.34	47.33	3,498.66	68.63	6,538.00	50.20	1,389.96	25.74

1/ Total value of pelts---number trapped x average pelt price

2/ Average dollars realized per trapper---average catch per trapper x average pelt price.

ANTICIPATED ACTIVITIES FOR NEXT QUARTER

Trapper interviews and statistical analysis of all data gathered to date will be performed during the next quarter. Yellowstone River vegetation maps and graphs for data presentation will be drafted.

Task 3 is estimated to be 65% complete.

TASK 4. ASSESSMENT OF THE IMPACT OF ALTERED STREAM FLOWS ON AGRICULTURE WHICH IS DEPENDENT UPON IRRIGATION . The Grantee shall estimate the future demand for agricultural projects provided by irrigated farming. The Grantee shall project what further irrigation development could occur in the study area on the basis of the existing resource base. The Grantee shall ascertain and, insofar as possible, quantify potential physical and economic constraints that may result from the use of water for coal development.

FARM BUDGETS

Future irrigation development in the Yellowstone Basin will be limited by, among other things, the cost of delivering water to the crops. Farm budgets provide a useful tool for estimating the farmers' ability to pay these costs. Studies on the Yakima River Basin in south-central Washington (Wash. State Univ. 1972) and the West River Study in North Dakota (N. Dakota State Water Comm. 1975) have used the farm budget approach to determine irrigation feasibility. The farm budgets used in this study compute the per-acre capacity to pay all irrigation costs. Allowances are made for costs associated with return-to-management, family labor, and return-on-investment. The remaining farm income can be used entirely for irrigation costs.

The budget is based on a 320-acre farm, since most of the available data are calibrated for this size farm. However, all farms vary in size, management ability, and availability of machinery, equipment, and capital. Therefore, it is important to determine how changes in any part of the budget will affect the payment capacity. To help analyze these changes, a computerized linear program, which permits easy manipulation of the data and computes the marginal value of all input items, is used to calculate all budgets. The sensitivity of the payment capacity to such variables as interest rate, crop prices, management levels, and cropping patterns can then be easily determined.

The budget described in this report utilizes the historic cropping pattern which reflects current practices in the lower portion of the basin and serves as a test of all data used in the budget. Table 19 is a financial summary of the data used and serves as an index to the remaining tables which also apply to this cropping pattern. Most of the data used in the budget were provided by the U.S. Bureau of Reclamation, checked against similar data available from the Cooperative Extension Service (CES 1969-72), and indexed to October, 1974, normalized prices (U.S. WRC 1974).

The acreage planted to any particular crop in these calculations will be varied to reflect local conditions and farmer preferences and to test the sensitivity of the payment capacity to the entire range of conditions possible

TABLE 19.[1/] Financial summary--320 acre farm, historic cropping pattern

Item	$ Value	Computation Tables
Farm Income		
Crops	54,469.41	20, 24
Livestock	23,121.88	24, 25
Perquisites	2,261,03	26
Gross Farm Income	79,852.32	
Farm Expenses		
Seed	1,924.79	21
Fertilizer	4,370.72	22, 23
Depreciation	1,765.08	27
Repair	1,198.00	27
Investment	13,196.78	27, 28, 29
Taxes	1,902.80	30
Labor	1,191.44	31
Miscellaneous	9,042.75	32
Gross Farm Expenses	34,592.36	
Net Farm Income [2]	45,250.96	
Management Allowance	4,525.10	
Family Labor	5,830.00	
Total Payment Capacity	34,895.86	
Per-acre Capacity [3]	110.78	

1/ All data used in the budget was provided by the USBR except as noted in the tables.

2/ Management allowance is 10% and Family labor 13% of Net Farm Income.

3/ Based on 315 productive acres.

in the basin. Four different cropping patterns will be tested:

1. Historic cropping pattern
2. High cash crop production pattern
3. High grain production pattern
4. High livestock production pattern

The historic cropping pattern was derived from a 10-year average of crops grown on USBR projects in the basin.

The high cash crop pattern will maximize the acreage planted to high-value cash crops. The high grain production pattern will be used for areas which are unable to grow sugar beets or for the entire basin if additional sugar beet processing facilities are not available. Finally, the high livestock production alternative will be used when climatic conditions or farmer preferences limit production to forage crops. All cropping patterns are adjusted to ensure proper crop rotations for disease control and soil fertility.

Five crops are being considered in the budget: sugar beets, barley, alfalfa, corn silage, and pasture (table 20). These are the primary crops currently grown in the basin, and may be viewed as representative of classes of crops which could be grown in the future. Sugar beets, for example, are the main cash crop currently produced. However, this crop also represents other potential cash crops such as potatoes, dry beans, or soybeans. Similarly, barley represents all small grains, and alfalfa represents all hay crops.

Crop yield estimates reflect moderately high management levels utilizing currently available technology. It is assumed that the high cost of pumping water will require proper management to ensure a reasonable profit.

Seed and fertilizer application rates were set for each crop based on the expected yield. The seeding rate for alfalfa and pasture assumed the stand was maintained for 3 years (table 21). Fertilizer application rates included the use of manure when livestock were present (tables 22 and 23).

The livestock enterprise is limited to on-farm production for cropping patterns which emphasize crop production (table 24). However, the livestock production alternative will include options for purchasing additional feeder cattle and feed.

A cow was assumed to have an average productive life of 8 years. Replacement heifers were taken from the feeder operation and kept 2 years prior to breeding. One bull, with a maximum reproductive life of 6 years, was kept for each 30 cows. Cows and bulls were kept in a closed pasture during the breeding season to ensure the maximum calf crop. Under these conditions, a 95% calf crop was assumed with a 1:1 steer-heifer ratio. Death losses were accounted for by reducing cattle sales by 2.5% (table 25).

In addition to the cash income derived from the crop and livestock enterprises, the farmer also receives certain perquisites as a result of living on the farm. For example, a nonfarm person usually pays the cost of owning and maintaining a house and the associated water supply from his personal income.

TABLE 20. Crop production & disposal, historic cropping pattern.

Crop	Unit	Production Acres 1/	Yield 2/	Total	Feed Use	Sale Amount	Price/Unit 3/	Total
Barley	bu	66	74	4884	2759	2125	$ 1.26	$2,677.50
Alfalfa	Ton	69	5	345	181	164	33.40	5,477.60
Sugar Beets	Ton	91	21	1911		1911	19.21	36,710.31
Pasture	AUM	54	5.5	297	297			
Corn Silage	Ton	35	21	735	49	686	14.00	9,604.00
Aftermath Grazing:								
Alfalfa	AUM	69	1.0	69	69			
Sugar Beets	AUM	91	5.13	277	277			
							TOTAL	$54,469.41

1/ Crop production occurs on 315 acres. The remaining 5 acres are used for buildings, roads, and waste land.

2/ Yield projections developed by Glenn Smith and Philip Threlkeld, DNRC.

3/ Price for corn silage was provided by the USBR. All other prices from the Water Resources Council (WRC 1974)

TABLE 21. Seed costs, historic cropping pattern.

Crop	Seeding Rate/Acre	Acres	Total Seed	Price	Total Cost
Barley	2 bu	66	132 bu	$ 3.40/bu	448.80
Alfalfa	3 lbs	69	207 lbs	1.68/lb	347.76
Sugar Beets	2.5 lbs	91	227 lbs	2.50/lb	568.75
Pasture	3.3 lbs	54	178 lbs	.93/lb	165.73
Corn Silage	.5 bu	35	18 bu	22.50/bu	393.75
		315		TOTAL	$1924.79

TABLE 22. Fertilizer replacement table, historic cropping pattern

Crop	Total Yield	Nutrients Removed # N 1 Unit	# N Total	# P_2O_5 1 Unit	# P_2O_5 Total	Nutrients Replaced Manure Added	lb.N_2 /Unit	lb.N_2 Total	lb.# P_2O_5 /Unit	lb.# P_2O_5 Total
Barley	4884 bu	1.20	5861	.53	2589	2759	.54	1490	.36	993
Alfalfa	345 Ton			9.60	3312	181	17.28	3128	6.05	1095
Sugar Beets	1911 Ton	6.40	12230	2.06	3937	1911	.54	1032	.16	306
Pasture	297 AUM	16.90	5019	5.00	1485	297	10.21	3032	3.15	936
Corn Silage	735 Ton	6.80	4998	2.80	2058	49	3.06	150	1.76	86
		TOTAL	28108		13381			8832		3416

TABLE 23. Fertilizer costs, historic cropping pattern

	N	P_2O_5
Nutrients Removed	28,108	13,381
Nutrients Replaced	8,832	3,416
Net loss	19,276	9,965
Natural Fixation Factor	x .75	x 1.0
Fertilizer Needs	14,457	9,965
Cost per lb.	.201	.147
Total Cost	$2,905.86	$1,464.86

TABLE 24. Livestock feed requirements, historic cropping pattern

	# of Head	Alfalfa, tons		Corn Silage, tons		Barley, bu		Pasture & Aftermath, AUM	
		Per Head	Total	Per Head	Total	Per Head	Total	Per Head	Total
Cows	75	1.75	131					7.00	525
Heifers 1's	9	.40	4	1.00	9			4.30	39
Heifers 2's	9	1.40	13					5.60	50
Bulls	3	2.20	7					8.70	26
Feeder Steers	36	.45	16	.68	24	46.9	1688		
Feeder Heifers	26	.40	10	.60	16	41.2	1071		
Feed Required			181		49		2759		640
Feed Produced			345		735		4884		643
Feed Available for Sale			164		686		2125		

TABLE 25. Livestock production and sales, historic cropping pattern

Livestock	# of Head	Production (lbs)			Sales	
		Per Head	Death Loss	Net	Price/CWT[1/]	Total Value
Cull Cows	9	1,100	248	9,652	$29.10	2808.73
Feeder Steers	36	900	810	31,590	40.10	12667.59
Feeder Heifers	26	800	520	20,280	37.70	7645.56
					TOTAL	23,121.88

1/ Price of feeder heifers is from Water Resources Council (WRC 1974) other prices from USBR.

However, these items are a part of the total farm operation, and their costs are allocated to the farm enterprise when determining total farm expenses. The farmer receives these items as a benefit, and the normal costs associated with them become a form of income to the farmer (table 26).

Depreciation, repair, and investment costs were determined for all buildings, machinery, and equipment used on the farm. Depreciation costs were computed on all items using a 6.5% sinking fund factor over the expected life of the item (table 27). Repair costs were assumed to be 2% of the value on buildings and improvements and 2.5% on machinery and equipment. A 7.1% return on investment was calculated on all investments, including livestock (USDA Economic Research Service 1974) (tables 28 and 29).

Taxes were estimated for all property listed in the budget (table 30). Taxes were levied against 30% of the assessed value on land and buildings, 20% on machinery and equipment, and 33% on livestock. The average assessed value for an acre of irrigated land was $42.87 in 1974. Buildings and improvements were assessed at 40%, machinery and equipment at 50%, and livestock at 60% of their average values. The average mill levy in the Yellowstone Basin was 160 mills in 1974 (Montana Dept. of Revenue 1974).

TABLE 26. Farm perquisites, historic cropping pattern. (House & Domestic Water)

Item	Perquisite Value	Computation Table
Depreciation	67.46	27
Interest on Investment	1476.80	27, 29
Repairs	416.00	27
Taxes	199.68	30
Insurance	101.09	32
TOTAL	$2261.03	

The labor requirements for each crop and livestock operation were computed on a monthly basis (table 31). Available family labor was used whenever possible and charged the minimum wage of $2.00/hour. Additional labor was hired during peak work periods at the rate of $2.12/hour, which includes the minimum wage and social security payments. To compensate the farmer for his time spent in management activities, 10% of the net farm income is set aside as a management allowance.

Sugar beet thinning and grain combining were considered to be custom contracted, and the costs included in the miscellaneous cost portion of the budget (table 32). Other crop-related items included in this category are the costs of seed treatment, pesticides, and baling twine. Miscellaneous livestock costs include veterinary costs and bull depreciation allowance. All costs associated with owning the operating the farm trucks, tractors, and automobile are included in this section. Finally, general farm costs such as insurance, electricity, and telephone charges are listed in the miscellaneous category (table 32).

TABLE 27. Inventory of buildings, machinery & equipment, repair and depreciation costs, historic cropping pattern

Item	Original Cost	Inventory Value	Repairs 1/	Depreciation 2/
House	20,000	10,000	400	58.20
Garage	2,000	1,000	40	11.38
Granary	1,500	750	30	38.64
Shop	1,500	750	30	38.64
Fuel Tanks	400	200	8	10.30
Barn	4,600	2,300	92	53.27
Fences	3,200	1,600	64	132.36
Well	800	400	16	9.26
Plow	1,200	600	24	69.08
Disk	1,400	700	28	57.89
Harrow	320	160	6	8.24
Sugar Beet Equipment	6,380	3,190	128	367.30
Drill	1,400	700	28	36.06
Planter	1,610	805	32	66.57
Cultivator	1,275	638	26	73.40
Loader	1,020	510	20	58.72
Wagon	600	300	12	24.81
Sprayer	640	320	13	26.46
Livestock Equipment	2,000	1,000	40	23.16
Baler	3,500	1,750	70	259.35
Windrow	3,600	1,800	72	266.76
Auger	630	315	13	26.05
Small Tools	280	140	6	49.18
Trucks	8,500	4,250	3/	3/
Auto	3,500	1,750	3/	3/
Tractors	6,500	3,250	3/	3/
TOTAL	78,355	39,178	1,198	1,765.08

1/ Repair costs for buildings and improvements calculated at 2% and machinery and equipment repair cost at 2.5% of original cost.

2/ Depreciation was computed using a sinking fund factor at 6.5%.

3/ Depreciation and repair computed in table 32.

TABLE 28. Livestock investment, historic cropping pattern

Livestock	Number	Value	
		Per Head	Total
Beef Herd	75	$275	$20,625
Heifers 1's	9	200	1,800
Heifers 2's	9	250	2,250
Bulls	3	600	1,800
Fed Heifers	26	140	3,640
Fed Steers	36	150	5,400
TOTAL	158		$35,515

TABLE 29. Return on investment, historic cropping pattern

Item	Value	Interest @ 7.1% 10/
Land @ $225/ac. 9/	$ 72,000	$ 5,112.00
Buildings & Machinery	78,355	5,563.21
Livestock	35,515	2,521.57
TOTAL	$185,870	$13,196.78

9/ Since irrigated land values reflect development costs, a value for non-irrigated land was used here. Investment costs for irrigation development are calculated in another portion of the study.

10/ Three year average rate (USDA, ERS. 1974)

TABLE 30. Tax computation, historic cropping pattern

Item	Taxable Value	Mill Levy	Tax
Land	4,115.20	160	658.43
Buildings	1,848.00	160	295.68
Machinery	2,377.80	160	380.45
Livestock	3,551.50	160	568.24
TOTAL			1,902.80

TABLE 31. Labor requirements and tractor hours, historic cropping pattern

Item	Acres or Head	Hours/Unit		Total Hours		Seasonal Distribution (labor hours)											
		Man	Tractor	Man	Tractor	J	F	M	A	M	J	J	A	S	O	N	D
Barley	66	2.37	1.80	156	119			16	31	16	17	17	39	20			
Alfalfa	69	6.93	4.06	478	280			10	53	166	48	91	110				
Sugar beets	91	13.78	6.60	1254	601			63	226	88	63	150	100	100	464		
Pasture	54	3.00	1.12	162	60				29	18	25	36	36	18			
Corn Silage	35	8.02	3.12	281	109					84	42	29	29	97			
Beef Herd	84	7.00	.35	588	29	59	59	71	76	41	29	29	29	29	41	71	54
Fed Steers	36	7.53	.38	271	14	54	54	27							27	54	55
Fed Heifers	26	7.50	.38	195	10	39	39	20							20	39	38
Replace Heifers	9	5.00	.25	45	2	9	9	5							5	9	8
Manure Haul	62	.75	.35	47	22			10	24	13							
Total Tractor Hours					1246												
Total Labor Hours				3477		161	161	222	439	426	224	352	343	264	557	173	155
Available Family Labor				3430		210	210	240	280	300	380	380	380	300	280	260	210
Hired Labor				562					159	126					277		
Cost @ $2.12/hr				$1,191.44													
Family Labor Used				2915		161	161	222	280	300	224	352	343	264	280	173	155
Cost @ $2.00/hr				$5,830.00													

TABLE 32. Miscellaneous costs, historic cropping pattern

Item	Amount Used	Rate	Total Cost
Tractor	1,246 hrs	$ 2.50/hr.	$3,115.00
Auto	3,000 mi.	.12/mi.	360.00
2 T Truck	3,500 mi.	.24/mi.	840.00
½ T Truck	5,000 mi.	.12/mi.	600.00
Telephone			80.00
Electricity			185.00
Insurance			
Buildings	15,000	9.72/1,000	145.80
Auto			35.00
Truck 2 T			70.00
Truck ½ T			40.00
Custom Combine	66 acres	7.00/acre	462.00
S. Beet Harvest	91 acres	21.00/acre	1,911.00
Barley Seed Treatment	66 acres	1.05/acre	69.30
Alfalfa Inoculation	69 acres	1.50/acre	103.50
Twine	345 tons	.55/ton	189.75
Veterinary			390.60
Beef Herd	93	4.20/cow	8.40
Bulls	3	2.80/bull	167.40
Feeders	62	2.70/feeder	270.00
Bull Depreciation	3	90.00/bull	
TOTAL			$9,042.75

CROSS-SECTION SURVEYS

Figure 4 shows the present status of the cross-section surveys. Reduction of field data and drafting is ongoing.

NEXT QUARTER'S ACTIVITIES

During the next quarter, additional farm budgets will be run to calculate the payment capacity for different situations. Irrigable land will be mapped and tabulated according to pipeline length and lift requirements, and the corresponding water delivery cost tables will be completed. All costs associated with on-farm irrigation equipment will be computed. Finally, data synthesis and analysis will be started, and preliminary conclusions should be available.

Task 4 is about 65% completed.

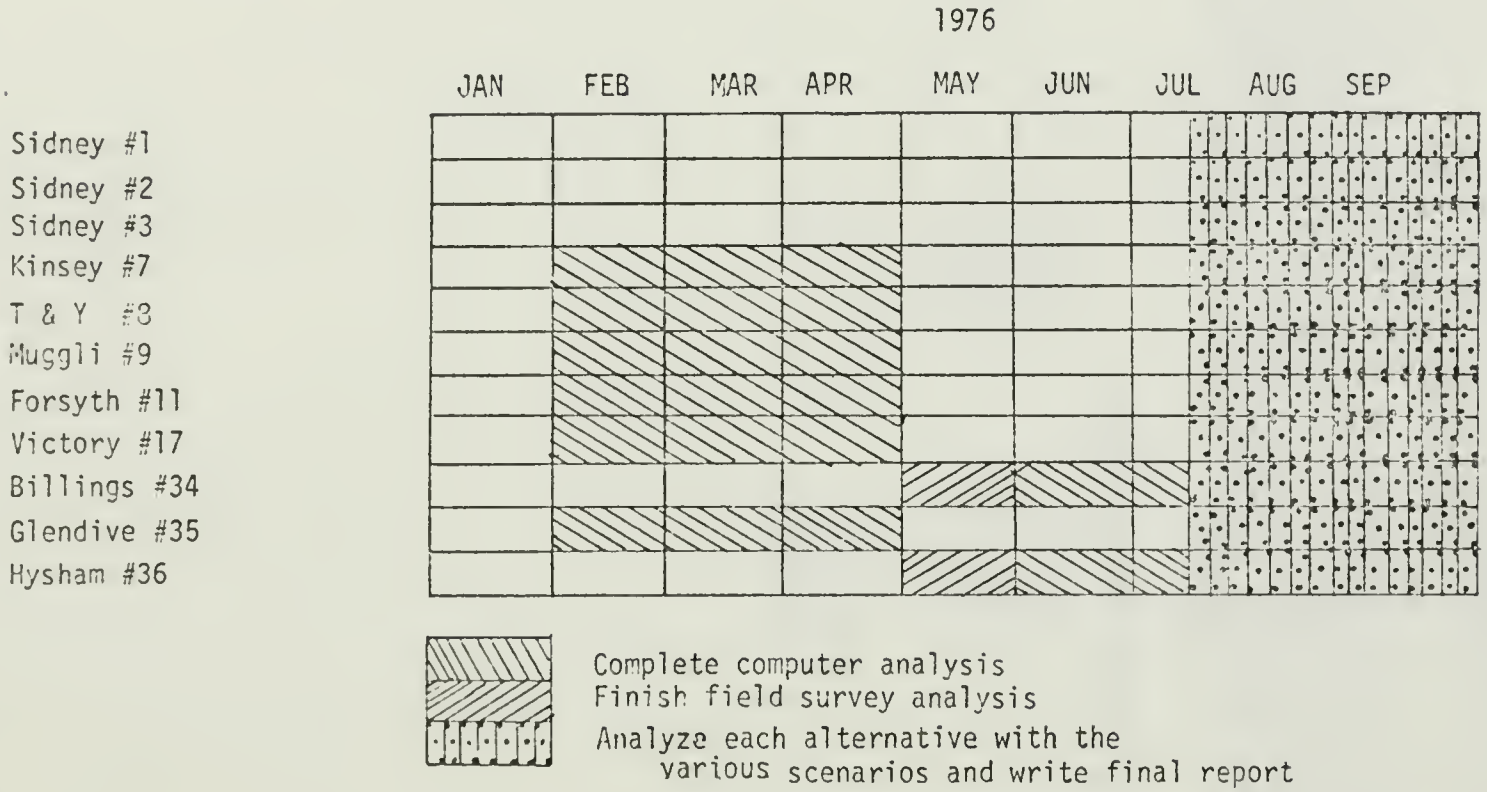

Figure 4. Yellowstone River Basin Old West Study Cross Section Schedule.

TASK 5. ASSESSMENT OF THE IMPACT OF ALTERED STREAM FLOWS ON MUNICIPAL AND NON-ENERGY INDUSTRIAL WATER SUPPLIES. The Grantee shall identify existing uses and sources of supply. The Grantee shall project future water needs for existing municipalities and for selected developing communities. The Grantee shall then assess the effects of water storage and diversion upon each community.

During the quarter, previously developed energy projections were modified and disaggregated into subbasins. Two synthetic crude plants were added to the high scenario for the year 2000. To reflect current thinking on technological and demand constraints on future gasification the number of gasification plants was reduced from the 15 projected by the Northern Great Plains Resources Program (NGPRP 1975) to 3. Export by slurry pipeline is assumed to account for the percentages of total exports shown in table 33. Slurry water is assumed to be half ground water and half surface water.

TABLE 33. Percentage of coal export by slurry pipeline.

	1985	2000
Low	0	0
Intermediate	0	20
High	20	40

Strip mines are assumed to be located, by tonnage, in the following subbasins: 42B&C (Tongue River), 45%; 42KJ&A (Rosebud Creek and Yellowstone mainstem from Bighorn to Miles City), 35%; 42J&I (Powder River), 10%; and 42O&P (Bighorn River), 10%.

Water requirements for coal mining and conversion processes are shown in table 34.

TABLE 34. Water requirements for coal processes.

Thermal electric generation	15,000 AF/yr/1000 MW
Gasification	9,000 AF/250 MM cfd
Slurry	750 AF/MMT
Syncrude	29,000 AF/100,000 BD
Strip mine	50 AF/MMT

Tables 35 through 38 show the disaggregated energy-related water use for the base, low, intermediate, and high scenarios in the years 1980, 1985, and 2000. Table 39 shows projected energy-related use for the entire basin.

During the next quarter, irrigation and municipal water consumption will be added to the energy-related water use projections. The resulting water use scenarios will be simulated with the State Water Planning Model.

Task 5 is about 65% finished.

TABLE 35. Water requirements for energy, acre feet/yr. Bighorn River subbasin (42P&O)

		AF/YR		
		1980	1985	2000
BASE	Electric Generation			
	Synthetic Gas			
	Slurry			
	Strip Mine	225	225	265
	Total	225	225	265
LOW	Electric Generation			
	Synthetic Gas			
	Slurry			
	Strip Mine	225	385	650
	Total	225	385	650
INTERMEDIATE	Electric Generation			
	Synthetic Gas			
	Slurry			1,250
	Strip Mine	250	600	1,325
	Total	250	600	2,675
HIGH	Electric Generation			15,000
	Synthetic Gas			
	Synthetic Crude			
	Slurry			3,900
	Strip Mine	250	800	2,000
	Total	250	800	20,900

TABLE 36. Water requirements for energy, acre feet/yr. Rosebud Creek and Mid-Yellowstone mainstem (42KJ & A)

		AF/YR		
		1980	1985	2000
BASE	Electric Generation	5,000	15,000	15,000
	Synthetic Gas			9,000
	Slurry			
	Strip Mine	780	780	920
	Total	5,780	15,780	24,920
LOW	Electric Generation	5,000	15,000	30,000
	Synthetic Gas			9,000
	Slurry			
	Strip Mine	780	1,360	2,270
	Total	5,180	16,360	41,270
INTERMEDIATE	Electric Generation	15,000	30,000	45,000
	Synthetic Gas			9,000
	Slurry			8,000
	Strip Mine	880	2,100	4,710
	Total	15,880	32,100	66,710
HIGH	Electric Generation	15,000	30,000	45,000
	Synthetic Gas			18,000
	Synthetic Crude			29,000
	Slurry		2,750	24,500
	Strip Mine	880	2,800	6,955
	Total	15,880	35,550	123,455

TABLE 37. Water requirements for energy, acre feet/yr. Tongue River Basin (42B&C)

		AF/YR		
		1980	1985	2000
BASE	Electric Generation			
	Synthetic Gas			
	Slurry			
	Strip Mine	1,040	1,040	1,170
	Total	1,040	1,040	1,170
LOW	Electric Generation			
	Synthetic Gas			
	Slurry			
	Strip Mine	1,040	1,710	2,970
	Total	1,040	1,710	2,970
INTERMEDIATE	Electric Generation			30,000
	Synthetic Gas			
	Slurry			10,000
	Strip Mine	1,120	2,700	3,660
	Total	1,120	2,700	43,660
HIGH	Electric Generation			45,000
	Synthetic Gas			9,000
	Synthetic Crude			29,000
	Slurry		3,350	27,000
	Strip Mine	1,120	3,600	8,960
	Total	1,120	6,950	118,960

TABLE 38. Water requirements for energy, acre feet/yr. Powder River Basin (42J&I)

		AF/YR		
		1980	1985	2000
BASE	Electric Generation			
	Synthetic Gas			
	Slurry			
	Strip Mine	225	225	265
	Total	225	225	265
LOW	Electric Generation			
	Synthetic Gas			
	Slurry			
	Strip Mine	225	385	650
	Total	225	385	650
INTERMEDIATE	Electric Generation			15,000
	Synthetic Gas			
	Slurry			1,250
	Strip Mine	250	600	1,325
	Total	250	600	15,575
HIGH	Electric Generation			15,000
	Synthetic Gas			
	Synthetic Crude			
	Slurry			6,900
	Strip Mine	250	800	2,000
	Total	250	800	23,900

TABLE 39. Water requirements for energy, acre feet/yr. Yellowstone River Basin, Montana

		AF/YR		
		1980	1985	2000
BASE	Electric Generation	5,000	15,000	15,000
	Synthetic Gas			9,000
	Slurry			
	Strip Mine	2,270	2,270	2,620
	Total	7,270	17,270	26,620
LOW	Electric Generation	5,000	15,000	30,000
	Synthetic Gas			9,000
	Slurry			
	Strip Mine	2,270	3,840	6,540
	Total	7,270	18,840	45,540
INTERMEDIATE	Electric Generation	15,000	30,000	90,000
	Synthetic Gas			9,000
	Slurry			20,500
	Strip Mine	2,500	6,000	11,020
	Total	17,500	36,000	130,520
HIGH	Electric Generation	15,000	30,000	120,000
	Synthetic Gas			27,000
	Synthetic Crude			58,000
	Slurry		6,100	62,300
	Strip Mine	2,500	8,000	19,915
	Total	17,500	44,100	287,215

TASK 6. INVESTIGATION OF EXISTING AND POTENTIAL IMPACTS OF COAL DEVELOPMENT ON WATER QUALITY. The Grantee shall perform five subtasks:

A) Gather and analyze water quality data for all significant surface waters in the area.

B) Investigate water quality problems directly associated with mining and energy conversion.

C) Investigate the adequacy of Montana's regulatory framework with respect to water pollution control.

D) Appraise the need for additional State water quality control efforts in view of the stresses of coal development.

E) Investigate the influences of stream dewatering on water quality.

ACTIVITIES DURING THE QUARTER

Approximately 60 water quality samples were collected and analyzed during the quarter. These included streams, irrigation return flows, and strip mine drainage. The Tongue River was sampled while the dam was being repaired in order to assess the impact of reduced flows on water quality. In conjunction with the Yellowstone-Tongue APO, two water quality runs were made: one, the week after the dam was closed, and another approximately four weeks later. The U.S. Geological Survey has agreed to provide copies of analyses of samples they collected during the second week of the shutdown.

Average monthly and average annual values for total dissolved solids (TDS) were computed for the following stream gauging stations for the time periods indicated:

Yellowstone River at Billings,	1951-1957
	1963-1969
Little Bighorn River below Pass Creek near Wyola,	1969-1974
Little Bighorn River near Hardin,	1969-1974
Bighorn River near St. Xavier,	1969-1974
Bighorn River at Bighorn,	1951-1965
	1966-1969
Yellowstone River near Miles City,	1969-1974
Tongue River at Miles City,	1951-1969
Tongue River at State line near Decker,	1966-1970
Powder River at Locate,	1951-1962
Yellowstone River near Sidney,	1951-1969

Linear regression equations were developed to relate monthly TDS in milligrams per liter to monthly discharge in acre-feet for the Tongue River at Miles City and Yellowstone River at Sidney, and to relate TDS at Sidney to TDS and flow at upstream stations.

The water quality index was computed for approximately 250 samples (see Montana Department of Natural Resources and Conservation 1975-the Annual Report-page 83).

Subtasks C & D of Task 6 were undertaken by the Department of Health's Legal Division during the quarter. A final-year law student at the University of Utah has begun review of Montana's regulatory framework regarding water quality control. During this past quarter, legal research and writing has been directed to the following water-quality issues:

1. Ramifications of the nondegradation concept for dewatering of the Yellowstone River; the possibilities of reserving flow rights to protect water quality; evidence of water quality degradation; the legal basis for issuing or denying water-withdrawal permits.

2. The possibilities of enforcing a zero discharge regulation against point sources, including but not limited to power, gasification, and liquifaction plants; the possibilities of enforcing temporal or seasonal discharges against point sources.

3. The adequacy of Montana's regulations relating to problems of irrigation return flow.

4. The legal provisions enacted in Montana to control nonpoint source waste.

5. Recommendations pertaining to various issues are embodied within the issue analysis.

6. The Federal Water Pollution Control Act Amendments of 1972 are discussed where deemed necessary for purposes of clarification.

NEXT QUARTER'S ACTIVITIES

Activities for next quarter will include the following:

1. Completion of the legal analysis and consideration of issues, including but not limited to surface- and ground-water laws and regulations, indirect sources of water pollution, and the Natural Streambed and Land Preservation Act of 1975.

2. Additional statistical analysis of water quality data.

3. Preliminary estimates of the impacts of coal development on water quality.

Task 6 is approximately 60% complete.

TASK 7. INVESTIGATION OF WATER-BASED RECREATION ON THE YELLOWSTONE RIVER. The Grantee shall perform three subtasks:

A) Compile and review current recreation usage of the Yellowstone study area in terms of volume, type, and geographic location.

B) Assess the impact of altered stream flows on current and potential recreational uses.

C) Conduct a field evaluation of alternative and additional recreation sites with potential for water-based recreation.

SUMMER RECREATION SURVEY

METHODS

Along the Yellowstone River five major study sections have been defined (figure 5), within each of which are popular places of recreational use.

Each section was visited randomly via automobile one day a week from June 22 to September 13, 1975, including weekends. Time of visitation occurred from either 6:00 A.M. to 2:00 P.M. or 2:00 P.M. to 10:00 P.M. To reduce error, sections were visited from west to east one week and east to west the next, throughout the survey. Thus, specific areas of visitation within each section were not visited at the same time of each day during the total survey period.

At each visitation site, the total number of people present and their recreational activities were observed. The date, river section, weather, time period, and number of vehicles were also recorded.

In addition, a questionnaire was dispersed to and completed on site by a sample of the total groups observed. From visual observations, groups (defined as a number of persons who had traveled to an area together or lone person) could usually be identified easily.

Data analysis procedures were of two types. First, questionnaire data were summarized in total and by section. Cross tabulations of various relationships were analyzed from totals. Second, data analysis for total observed use incorporated date, weather, time of day, section, time of week (weekday or weekend), and total water discharge. Correlation coefficients were calculated for each variable related to total use. A multiple regression using all factors tested for significance.

RESULTS

There were 212 questionnaires completed, each representing a group of

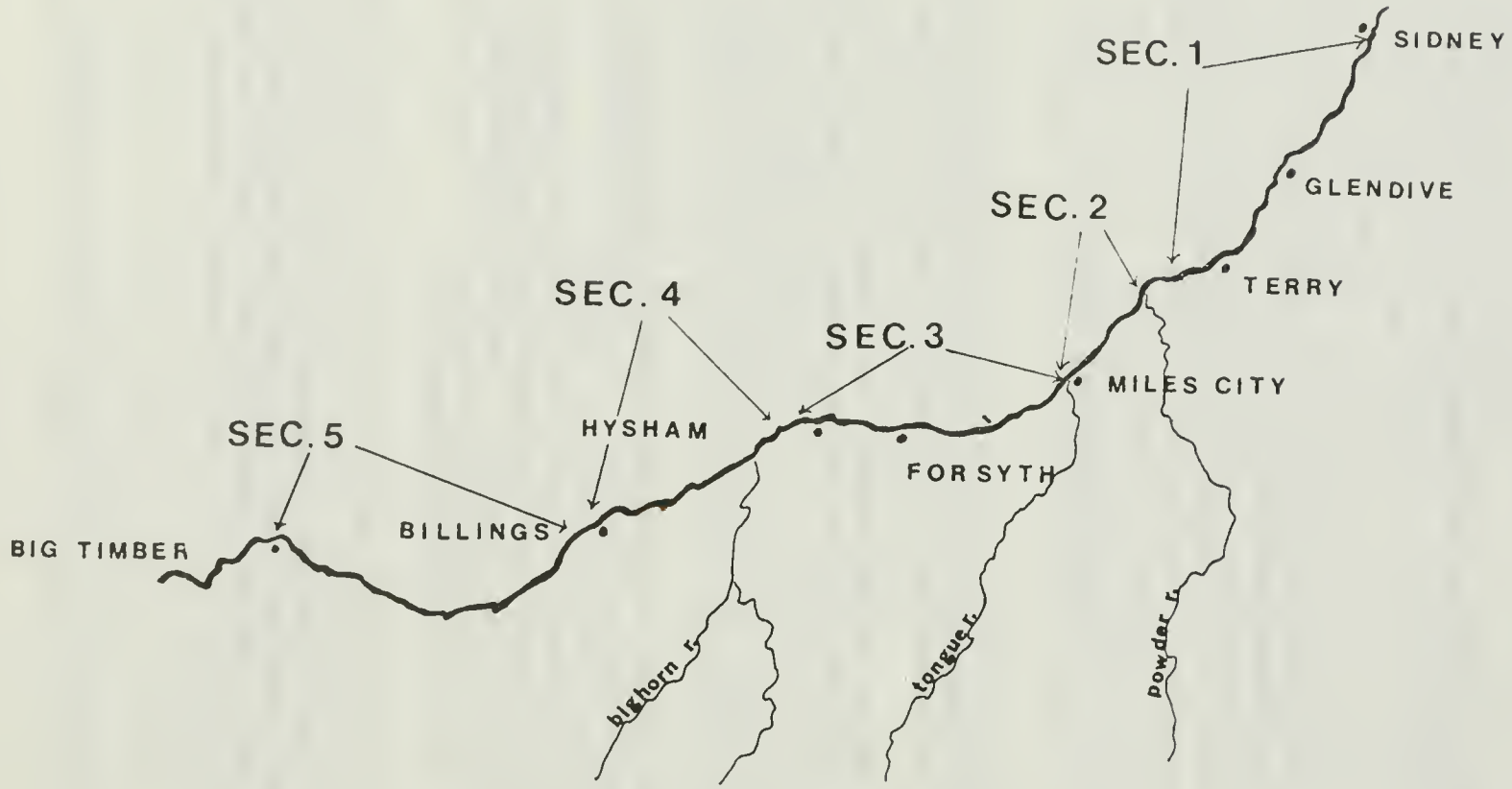

FIGURE 5. Yellowstone River study sections.

recreationists. Note that all percentage totals are not 100% because some responses were judged invalid.

Question 1. Are you presently on your vacation? (210 valid responses)

Yes--24.3%
No--75.7%

Question 2. a) Was recreation on the Yellowstone River and/or its tributaries the primary purpose of your trip? (198 valid responses)

Yes--54.0%
No--46.0%

b) If not, what is the main reason for your trip? (129 valid responses)

Rest and relaxation--42.6%
Visting relatives and/or friends--12.4%
Sightseeing--12.4%
Business--12.4%
Other reasons--7.8%

The combined 55% for sightseeing and rest and relaxation did not consider those activities recreation, per se.

Question 3. a) How often do you visit this particular site each summer? (199 valid responses)

Eight times--29.6%
Never before--22.6%
Four to six times--10.6%

b) How may times do you visit this particular site during the: 1) spring (122 valid responses), 2) fall (100 valid responses), 3) winter? (53 valid responses)

1) One to two times--37.7%
   Three to six times--27.9%
   More than eight times--27.0%

2) One to two times--30.0%
   Three to six times--31.0%
   Seven to eight times--12.0%
   More than eight times--27.0%

3) One to two times--49.1%
   Three to six times--15.1%
   More than eight times--26.4%

The most missing seasonal observations occurred during the winter portion (159), while the least (13) occurred within the summer portion. Spring (90) and fall (112) were relatively close to the mean (93.5). Since there was no

category denoting no use, one may surmise that these data reflect seasonal use patterns, summer having the greatest and winter the least use.

Question 4. Have you noticed a change in a) water quality (155 valid responses), or b) quantity of litter since you started using the Yellowstone area for recreation? (142 valid responses) c) Has your enjoyment of the river increased, decreased or stayed the same? (154 valid responses)

a) Water quality had increased--23.2%
About the same--64.5%
Water quality had decreased--12.3%
NOTE: From personal communication, water quality, to the interviewees, was defined by the color and clarity of the water. Blue, clear water would be of good quality; murky, brown water would be poor.

b) Increase of litter--35.9%
Problem was the same--37.3%
Litter had decreased--26.8%

c) Enjoyment of river had increased--50.6%
Remained the same--44.2%

Question 5. What is the length of your present stay? (189 valid responses)

Day use--62.4%
One night--10.1%
Over ten nights--12.2%

From personal communication, non-residents and vacationers occupied the majority of the latter 12.2%, and responded not necessarily with their present location in mind, but with respect to their total duration of trip.

Question 6. a) For each activity you have engaged in or plan to engage in while in this immediate area, indicate the number of hours per day spent (table 40). b) Which of these are your favorite activities? (table 41). Fishing and rest and relaxation were apparently the recreational activities most often engaged in and most preferred during the survey period.

TABLE 40. Percentage of people engaged in various recreational activities (hours per day)

	HOURS PER DAY											No. Nonresponses[2/]
	1	2	3	4	5	6	8	10	12	14	24[1/]	
Picnicking	42.2	40.0	2.2			4.4	6.7		2.2	2.2		167
Horseback riding	25.0	25.0					50.0					208
Bicycling	37.5	25.0	12.5	12.5			12.5					204
Playing outdoor games	40.0	10.0	20.0	10.0			10.0				10.0	202
Swimming	42.1	26.3	5.3	5.3	5.3		5.3				10.6	193
Water skiing	25.0		25.0			25.0	25.0					208
Motor biking	14.3	14.3	14.3		42.9		14.3					205
Motor boating	47.1	35.3		5.9			11.8					195
Rest & Relaxation	24.0	20.0	5.3	13.3	8.0	4.0	9.3	4.0	4.0		9.0	137
Sightseeing	40.0	40.0				5.0	10.0				5.0	192
Walking, hiking	31.3	6.2		18.8	12.5	18.8	6.2				6.2	196
Bird watching	33.3	33.3					16.7				16.7	206
Rock hounding	50.0	19.2	3.8			7.7	11.5				7.6	186
Pleasure driving	58.3	16.7	8.3		8.3		8.3					200
Fishing	15.8	14.9	8.9	20.8	9.9	16.9	6.9		2.0		1.0	111

1/ Common sense would indicate that these activities were not engaged in for 24 hours per day.

2/ Nonresponses are categories which were not answered. It is assumed that the majority of these nonresponses did not engage in the indicated recreational activity.

TABLE 41. The most favored recreational activity (159 valid responses)

Activities	Percentage
Picnicking	1.3
Swimming	7.5
Water skiing	.6
Motor biking	1.3
Motor boating	1.9
Rest and relaxation	15.1
Sightseeing	3.8
Walking and hiking	2.5
Floating	4.4
Rock hunting	4.4
Fishing	57.2
Total	100.0

Question 7. a) If you fished in this area, for which species? (table 42)

b) Which species did you catch, and how many? (table 43)

The actual number of fish caught by the 16.9% of successful fishermen varied. Without regard to species, 80.6% of them caught from one to six fish. (31 valid responses)

TABLE 42. Species sought by fisherman (181 valid responses)

Species	Percentage
Pike, sauger, walleye	46.5
Paddlefish	7.8
Catfish	24.1
Sturgeon	0.9
Ling	1.7
Sucker, carp	5.2
Trout	30.3
Bass	2.6

TABLE 43. Species caught by fisherman (31 valid responses)

Species	Percentage
Pike, sauger	28.6
Paddlefish	6.3
Catfish	27.0
Sturgeon	4.8
Bullhead	1.6
Ling	3.2
Sucker, carp	4.8
Goldeye	7.9
Trout	12.7
Bass	1.6
Whitefish	1.6

Question 8. Rate each of the following criteria at this location. (table 44)

TABLE 44. On-site facility and recreational conditions rating

	Number of Valid Responses	Percentage of Valid Responses			
		Exceptional	Good	Fair	Poor[1]
Picnic facilities	150	10.7	40.0	24.0	25.3
Rest rooms	138	8.0	25.4	21.0	45.7
Camping sites	145	10.3	35.9	31.7	22.1
Children's activities, equipment	111	2.7	14.4	16.2	66.7
Weed mowing	130	5.4	20.8	20.8	54.6
Access roads	165	11.5	32.7	32.7	18.8

1. The "poor" category includes responses at locations where certain activities and/or conditions were not present, including privately owned lands.

Question 9. Where would you go for the same activities if this site was not available?

The data collected were not uniform.

Question 10. Do you like that site as well as this one? (145 valid responses)

Yes--68.3%
No--31.7%

Question 11. a) What is your state of residence? (205 valid responses) b) County or town? (165 valid responses)

a) Montanans--81.5%

b) Billings--48.5%
Forsyth--11.5%
13 other towns in Montana--12.7%

Question 12. Check the broad income category your combined household fits into. (203 valid responses)

Under $4,000--13.6%
$5,000-$7,000--13.1%
$8,000-$11,999--25.6%
$12,000-$15,999--27.8%
Over $16,000--19.9%

Question 13. Do you think this site presently is too crowded, just right, or not used enough? (203 valid responses)

Too crowded--12.8%
Just right--71.9%
Was not used enough--15.3%

Question 14. Should the site be more fully developed? (197 valid responses)

Yes--62.7%
No--37.6%

Question 15. Within how many miles upstream or downstream would you like to see at least one more site? (173 valid responses)

Zero to five--28.9%
Five to 15--32.4%
Fifteen to thirty--22.5%
Over 30 miles--16.2%

Question 16. a) Has the increasing cost of gasoline decreased the distance you travel to a recreational area? (203 valid responses) b) Check the miles covered in a typical previous year's recreation trip, (190 valid responses), and c) Check the miles covered in a typical recreation trip this year. (195 valid responses)

a) Yes--57.7%
No--46.3%

b) Zero to 50 miles--14.2%
50-250 miles--25.8%
250-450 miles--16.3%
Over 450 miles--43.7%

c) Zero to fifty miles--20.5%
50-250 miles--31.8%
250-450 miles--16.4%
Over 450 miles--31.3%

An interesting note here is that the reported percentage of trips over 450 miles decreased significantly in 1975 while shorter recreational trips increased.

Question 17. a) Check the type of vehicle you arrived in. (204 valid responses) b) Check the items of equipment you have with you. (212 valid responses)

a) Car--49.8%
Pickup--22.7%
Pickup with camper--12.8%
Other modes--14.8%

b) Boats--17%
Tents--10.8%
Fishing gear--56.6%
Sleeping bags--23.1%
Firearms--14.1%

Question 18. Check your occupation. Check your spouse's occupation (table 45).

TABLE 45. Occupational percentages.

	(192 Valid Responses) Interviewee	(122 Valid Responses) Spouse of Interviewee
Self-employed white collar	5.7	5.7
Self-employed blue collar	6.8	2.5
Employed white collar	10.4	14.8
Employed blue collar	34.9	18.9
Professional	10.9	0
Student	7.8	0
Housewife	7.8	50.0
Agriculture	3.6	1.6
Retired	12.0	6.6

Employed blue collar was the most common form of employment of the interviewee, while housewife was the most common occupation of spouses.

Question 19. a) Check your sex. (204 valid responses) b) Check your age. (197 valid responses)

a) Males--68.3%
Females--31.7%

b) 5-18--10.7%
19-30--27.9%
31-50--37.1%
Over 50--24.4%

Question 20. Enter the number of other persons in your group within each age and sex category (table 46).

TABLE 46. Percentages of group ages

	1-12	13-18	19-30	31-50	Over 50
Males[1]	16.2 (69)	8.7 (37)	9.9 (42)	7.0 (30)	7.7 (33)
Females[2]	13.8 (59)	7.5 (32)	13.6 (58)	10.6 (45)	5.0 (21)
	30.0 (128)	16.2 (69)	23.5 (100)	17.6 (75)	12.7 (54)

1. Males - 111 valid responses

2. Females - 110 valid responses

The percentage figures (and the numbers in parenthesis) represent those people who responded that their groups contained the various age groups. Results were not valid for total numbers within each age and sex group.

Question 21. a) Are insects a problem to you in this area? (201 valid responses) b) Have they reduced the time you spend enjoying your favorite activities? (191 valid responses) c) Would you return to this area if the insect problem remains the same? (188 valid responses) d) Would you return to this area if the insect problem was reduced? (184 valid responses)

a) Yes--63.7%
No--36.3%

b) Yes--42.4%
No--57.6%

c) Yes--84.6%
No--15.4%

d) Yes--92.9%
No--9.1%

Question 22. a) Are you aware of the location of public lands along the river near this area? (192 valid responses) b) Are you aware of the location of public lands near your home if this area is not near your home? (155 valid responses) c) Do you know that literature is available at any Bureau of Land Management office providing information and the location of those areas, free of charge? (191 valid responses)

a) Yes--41.1%
No--58.9%

b) Yes--56.8%
No--43.2%

c) Yes--63.9%
No--36.1%

Question 23. Within the past year, in which of the following activities have you participated on these public lands adjacent to the Yellowstone River? (212 responses)

No activities--15.6%
Fishing--55.7%
Boating--25%
Picnicking--34.4%
Camping--28.8%
Hunting--28.3%
Other recreational activities--10.4%

Question 24. Yearly, how many days do you spend at other sites on the Yellowstone River and its tributaries (table 47)?

TABLE 47. Percentage of recreationists spending days at other sites.

	1	2-3	4-5	6-7	10-15	16-20	Over 20	None
Percentage of 199 valid observations	9.0	15.1	10.6	10.6	15.6	4.0	15.6	19.6

Cross Tabulations

Cross tabulations (CT) can now be used to 1) emphasize pertinent relationships, 2) provide a check system for total analysis, and 3) add validity to responses by considering only those interviewees that responded to both questions. The latter reason explains the difference between the numbers of valid observations recorded above and those recorded in this section. Responses of less than 10% are not reported here; thus total percentages may be less than 100%.

CT-1/(Q. 1 and 2). Of 197 valid observations, 43.1% replied that they were not on vacation and recreation was the primary purpose for their trip. Another 31% replied they were not on vacation and recreation on the Yellowstone was not the primary purpose for their trip. Of the 24.9% who were on vacation, 14.2% replied that recreation on the Yellowstone was the primary purpose and 10.7% replied that it was not.

CT-2/(Q. 42 and 4c). Of 137 valid observation, 11.7% replied that since they started using the Yellowstone they had noticed better water quality and their enjoyment of the river had increased.

Of the 67.2% who replied that water quality had remained the same, 32.8% replied that their enjoyment had increased, and 32.1% replied their enjoyment had stayed the same.

CT-3/(Q. 4b and 4c). Of 129 valid responses concerning litter and enjoyment of the river, 15.5% reported increased noticeable litter and increased enjoyment, 19.4% reported the same amount of litter and increased enjoyment, 16.3% reported decreased noticeable litter and increased enjoyment. Replies from 15.5% noted increased litter and the same general enjoyment, 17.1% replied that neither condition had changed, and 10.9% reported decreased noticeable litter but the same enjoyment. Thus, 94.7% reported that their enjoyment of the river had at least stayed the same regardless of the litter situation. From personal observations, no extreme amounts of litter were encountered.

CT-4/(Q. 16b and 16c). Of 188 valid responses, 30.4% indicated this year's recreational trip covered a shorter distance than previous years' typical trips, and 62.3% indicated trips within the same mileage categories.

CT-5/(Q. 5 and 16c). Of 175 valid responses, 61.7% responded that their length of stay was day use only. Sixteen percent of this total responded this year's typical recreational trip covered from 0-50 miles, 20.6% responded from 50-250 miles, 10.3% responded from 250-450 miles, and 14.9% responded over 450 miles.

CT-6/(Q. 13 and 14). Of 194 valid responses, 39.7% indicated that the area they were enjoying was just right (concerning crowding) and would like to see more site development; 12.9% indicated the area was not used enough but should have more development; and 31.4% thought the area was just right and wanted no more development.

CT-7/(Q. 11 and 16a). Of 197 valid responses, 80.7% were Montana residents. Of these, 45.2% noted a decrease in the distance they traveled to a recreational area due to the increasing cost of gasoline and 35.5% replied no effect.

CT-8/(Q. 12 and 16a). Of 171 valid responses, 53.8% of all income categories indicated that the increasing cost of gasoline had reduced the distance traveled to recreational areas. Only the highest income category, above $16,000 annually, indicated that there was no significant change.

CT-9/(Q. 14 and 16a). Of 193 valid responses, 35.8% of the 121 people who indicated there should be more development at their present recreational site replied that the cost of gasoline had decreased their recreational mileage, whereas 26.9% replied that it had not. Of the 72 people who indicated they wanted no further development for the

site, 16.6% replied that the increasing cost of gasoline had decreased their recreational mileage and 20.2% indicated it had not.

CT-10/(Q. 11 and 12). Of 171 valid responses, Montana residents' income categories were: under $4,000, 12.9%; $5,000-$7,999, 8.8%; $8,000-$11,999, 24.0%; $12,000-$15,999, 23.4%; and over $16,000, 13.5%.

CT-11/(Q. 22a and 22c). Of 182 valid responses, the 33.0% with knowledge of public land near (50 miles upstream or downstream) their present site also knew they could obtain information on these lands free of charge; 30.8% did not know the location of land near their present site but knew of the information available, and 29.1% did not know the location of nearby public land nor that free information was available concerning these lands.

CT-12/(Q. 15 and 22a). Of 164 valid responses, 35.3% of all responses indicated they knew of the public land along the river near their respective recreational site but would like to see another site within 30 miles upstream or downstream; 49.4% indicated no knowledge of public lands near their recreational area but would like to see another recreational site within 30 miles upstream or downstream.

CT-13/(Q. 21a and 21c). Of 185 valid responses, 49.2% indicated that insects were a problem in their area but would return if the problem persisted; 14.6% indicated they would not return.

CT-14/(Q. 21b and 21d). Of 182 valid responses, 29.7% and 21.1% indicated that insects had reduced recreational time and that they would not return to the area, respectively; 54.9% indicated that insects had not reduced recreational time and that they would return to the area.

CT-15/(Q. 5 and 6b). Of 144 valid responses, 36.1% listed their favorite activity as fishing and their length of stay as day use only.

Sectional Results

Variations in population and river gradient among sections result in variations in recreational activities. Impacts of streamflow modification may be mostly local or sectional. Thus, a sectional analysis of situations, experiences, and preferences is important. Such an analysis has been done but is not presented here.

EFFECTS FROM FLOW ALTERATION

People visit an area for a reason. That reason can be related to streamflow

through such parameters as biological conditions which influence fish feeding habits, levels of the river conducive to good rock hounding, and riparian vegetation. However, even these factors, although influential, cannot totally determine use. Amounts of leisure time, weather, time of day, day of week, distance from home, insect problems, and the financial ability to recreate are only a few of the variables that affect recreational use. At any one time, one factor may be the most influential, but interrelationships with others still exist. For example, even under optimum fishing conditions, recreational use is reduced drastically by adverse weather. This use could be reduced even further by the time of day and day of the week, assuming that most people work during the day on weekdays.

In order to determine which factors are most influential, the recreational use of the Yellowstone River (total number of people) was correlated with river section (location), maximum temperature of each day, river discharge (cfs), a description of weather conditions, the month, the date, the time of day (one of two time periods) and the time of week (weekdays vs. weekends). The correlation indicates that each factor independently has little effect upon total observed use. The largest correlation coefficient (.2616) related the effect weekday versus weekend use had on observed total use. Although each variable independently related little effect to total observed use, the combination of factors is important. The variables are, in order of significance: weekdays vs. weekends, section (location), discharge, discharge squared, and overall weather.

DISCUSSION AND CONCLUSIONS

The areas surveyed attracted residents versus non-residents by approximately four (81.5%) to one (18.5%). This ratio is slightly higher than results from a previous study including all types of recreational areas (Montana Fish and Game Commission 1972) with approximately the same geographical boundaries. The three planning regions included attracted residents at rates of 70.7% (planning region 2), 78.3% (planning region 3), and 75% (planning region 7).

Of the people surveyed in section 1, 75.9% were Montana residents; section 2, 87.7%; section 3, 87.2%; section 4, 93.8% and section 5, 69.8%. The lower percentage of residents within section five, from personal observation, is explained by substantial numbers of blue-collar workers who travel with available work. Within section 1, a substantial number of nonresidents were attracted by paddlefishing.

In addition, recreationists surveyed indicated summer as the highest season of recreational use, whereas winter commands the least use. Of the total number of people observed, rest and relaxation was the favored recreational activity with 26.3%, followed closely by fishing with 20.8%. Within sections one, three, and four, however, fishing was favored over rest and relaxation.

Fish species sought within the study area varied due to the cold- and warm-water biological variations within the study area. Of those surveyed in section five, 97.1% noted that trout was the most popular species sought.

Moving eastward, as the Yellowstone stream gradient decreases, section 4 recreationists listed favorite species as pike, walleye, sauger (39%); section 3, catfish (40.6%) and pike, walleye, sauger (43.7%); section 2, catfish; and section one, pike (33.3%); paddlefish (27.8%); and catfish (27.8%). Paddlefishing popularity, from personal observation, dominates within section one during late May and June.

A major water-based recreational event along the Yellowstone is the three-day, 126-mile, Yellowstone River boat float, which usually takes place the second weekend of July. The float begins in Livingston, Montana, and terminates at Billings, Montana. Although 97 boats were registered at Livingston, a count at Columbus on July 12 revealed 60 boats carrying 239 people, 7 canoes carrying 14 people and 3 kayaks carrying 5 people. An aerial count on July 13, from Columbus to Billings revealed 37 boats carrying 115 people, 7 canoes carrying 14 people, and 3 kayaks carrying 5 people. An estimated 1,000 people took part in the float, either as participants or sightseers.

Another boat float takes place annually at Terry on July 4. In 1975, 13 crafts carrying 61 people, made the trip from the mouth of the Powder River to Terry, a distance of 11.9 river miles. Total observed use was 225 people. The Yellowstone and Terry boat float figures are actual counts and should be considered as minimum use figures.

NEXT QUARTER'S ACTIVITIES

Activities for next quarter will entail analysis of recreational hunting use within the study area.

Task 7 is approximately 65% completed.

TASK 8. INVESTIGATION OF THE IMPACT OF ALTERED STREAM FLOWS ON CHANNEL PROCESSES AND DYNAMICS. The Grantee shall study stream channel processes and dynamics at various discharge rates to determine the effect of stream flow alterations on stream stage and channel stabilization. The Grantee shall provide hydrologic expertise for investigators engaged in other tasks set forth in this article.

VIGIL NETWORK SYSTEM

ACTIVITIES COMPLETED THIS QUARTER

Compilation of Field Data

Field notes were transcribed and all data rendered in tabular formats for typing for the final vigil network files. Plane-table survey sheets were inked and are in the final editing stage where uniformity of style and legends are ensured.

Analysis of Data

The first phase of an analysis intended to critically scrutinize the homogeneity of hydrographic variables in the eastern Montana coal region has been completed. For the vigil network information to be useable in a predictive fashion as well as its easily recognized baseline monitoring function, it is necessary to assess the degree of homogeneity of the hydrologic and physiographic characteristics of the region so that impacts upon unmeasured sites can be judged based upon scale factors from measured sites. This comprises so-called "dimensionless analysis" where regional characteristics of flow heights or flow duration are plotted as dimensionless ratios as a function of a physiographic variable such as basin size, shape, or aspect. This permits prediction of those hydrographic characteristics based upon a simply measurable parameter such as basin size and permits assessment of expected departures from predicted norms as a function of land use or flow modification. Basin hydrographic uniformity is assumed. Part of the vigil network provides input to assessment of that uniformity.

A preliminary analysis of discharge ratios versus basin size has yielded a wide scatter of points. It has been found that characterizing eastern Montana streams as all lying within a certain class of uniformity is not consistent with the existing data (Boner and Buswell 1970).

In an attempt to determine the most predictive hydrographic characteristics to use for subregions of the Powder River Basin and middle Yellowstone Basin, analyses of rainfall intensity and duration ratios versus runoff, basin size, basin shape, and basin aspect have been prepared. To date, the best predictive capabilities are through a model that breaks the Montana portion of the Powder

River Basin into three separate hydrographically distinct subregions based upon dimensionless analysis of rainfall intensity versus runoff. However, this work is preliminary and other variables need to be considered before a choice is made.

It has been tentatively concluded that the Montana coal region has some rather unusual streams that have flood-routing properties unlike most recorded in the literature. The combination of long, narrow drainage basins coupled with aridity and combinations of snowmelt and summer thunderstorm runoff peaking agents together yield distinctly differing runoff characteristics in the different subregions. The shortness of the precipitation and small watershed runoff records doubly hinder statistical evaluation of the regional hydrographic characteristics because of the high year-to-year variations observed in runoff and local precipitation.

An attempt is being made to include analyses of drainage density, relief ratios, and basin rugosity indices, all taken from topographic maps, as measures or indices of basin hydrographic uniformity. Initital work is promising and should provide additional supplemental or reinforcing information to complement other work. It is known that basin size, basin shape, and basin aspect do not provide adequate regression characteristics for predictive use for unmeasured rivers or sites.

PLANNED ACTIVITIES

Preparation of Vigil Network Files

Final editing will be completed and all the material for the vigil network files will be sent to the typist in the first quarter of 1976. Plane-table maps will be redrafted to uniform style, and map and tabular data will be physically combined into permanent files for each station. Photo format size will be 5 x 7 inches, and each photograph will be located on the plane-table map of the site within the file. Darkroom work has begun and files are to be typed beginning January 31, 1976.

Data Analysis

Further work continues on analysis of flow characteristics for the region included in the vigil network examination. Work on the geomorphic criteria for distinguishing subregion units of hydrographic uniformity will continue. This analysis will permit further work with the channel geometry characteristics derived from the vigil network program to assess the impact of altered streamflows on channel stability and geometry.

STREAM SEDIMENTATION AND CHANNEL MORPHOLOGY

Two field trips were made into the study area to determine channel characteristics at the sites where hydraulic geometry data are being compiled. An inspection was made at each site in an attempt to determine bankfull stage, and samples of bed and bank material were obtained. These bulk material samples were sieved in an attempt to establish any correlation of material size to width-depth ratio, sinuosity, or other channel characteristics.

Hydraulic geometry data have now been gathered for all stations in the basin where such data are available, and the appropriate curves have been determined. Downstream relationships are presenting a problem, however, since a method for establishing a flow of constant frequency for comparison has not yet been found for short-record stations. The determination of bankfull flow is being investigated.

Along with the above-mentioned hydraulic geometry investigations, the historic trends of hydraulic geometry in the basin are also being established. A computer program has been written for determining the hydraulic geometry coefficients and exponents for a given period of record. These data will then be analyzed for successive periods. For example, successive 5-year periods from 1940 to 1975 are being examined to establish historic changes which can then be analyzed to possibly predict future changes in the basin.

Finally, a Helley-Smith bed-load sampler (Helley and Smith 1971) has been ordered for the purpose of starting a sampling program in the spring.

EFFECTS OF FLOW CHANGES ON ALLUVIAL AQUIFERS

Recently, a cursory investigation has begun into the possible effects of flow changes on the alluvial aquifers in the lower Yellowstone Basin, apparently a complex system affected not only by river recharge, but in many cases also by recharge due to irrigation. Literature on the subject is being reviewed and a course of action will be selected in the near future.

Task 8 is approximately 65% completed.

TASK 9. WATER MODEL CALIBRATION AND RIVER BASIN SIMULATION. The Grantee shall calibrate the mathematical Montana water planning model to selected field impacts. The Grantee shall then conduct a series of computer runs to simulate the impacts of various degrees and configurations of water use.

The annual and monthly versions of the state water planning model have been calibrated for all Yellowstone basins in Montana except Pryor Creek and Rosebud Creek. Data are currently being prepared to include Pryor Creek with 43Q and Rosebud Creek with 42KJ. The small basins are being combined with the large basins because of the lack of outflow data for the small subbasins. Basins 43Q and 42KJ will have to be recalibrated to reflect the inclusion of the above subbasins; this should be complete by February, 1976.

The monthly version of the model for the Yellowstone Basin in Montana has been obtained, and simulation of basin-wide scenarios is being conducted. Simulations will be run for the Environmental Quality (EQ) Scenario, Economic Development (ED) Scenario, and intermediate scenarios by the State Water Planning Team. Some modifications will be required to the simulation model to obtain the desired results.

Some initital simulations have been done, and results are being reviewed.

During the next quarter, simulation of the basin-wide scenarios will be completed, and simulations of the subbasin scenarios will be well underway.

Task 9 is about 55% completed.

TASK 10. COMMENCEMENT OF FINAL IMPACT EVALUATION OF WATER WITHDRAWALS AND WATER DEVELOPMENT ON THE MIDDLE AND LOWER PORTIONS OF THE YELLOWSTONE RIVER DRAINAGE, MONTANA. The Grantee shall commence an analysis in three stages:

A) Determine the mixes of coal-based water consumption to be evaluated in future years.

B) Project the demands that other water users will impose in future years.

C) Analyze the field impacts of the foregoing competing demands.

Phase (A) of this Task has been discussed under Task 5; phase (B) is included in Tasks 4 and 5; phase (C) is an integral part of Tasks 1-9.

TASK 11. COMMENCEMENT OF ECONOMIC EVALUATION OF WATER WITHDRAWALS AND WATER DEVELOPMENT ON THE MIDDLE AND LOWER PORTIONS OF THE YELLOWSTONE RIVER DRAINAGE, MONTANA. The Grantee shall commence an economic evaluation of the impacts and assessments set forth in the foregoing tasks. The Grantee shall provide such coordination of the foregoing tasks as is necessary to make this economic evaluation.

RECREATION

Travel expenses for basin recreation will not be available, since those questions were not included in the final version of the summer recreation survey (see Task 7), so this approach to finding the value of the experience to the recreator will not be possible. Water Resource Council benefit figures are available and can be used as a last resort, with some caution (U.S. Forest Service 1973). It appears that lowering the river level within limits will not decrease the utility of recreational sites surveyed (Max Erickson, personal communication). If the river were lowered below the point necessary to maintain fish, the fishing success ratio would be decreased, and use might decrease. Information about substitutability of sites from the summer survey may be useful in determining irreplaceable loss of recreation benefits. Future work on this task will continue as more information is received from the Department of Fish and Game. In the meantime, several publications of assistance in the analysis and write up have been reviewed (Knetsch 1974, USFS 1973, North Dakota State Water Commission 1975, Polzin and Schweitzer 1975).

AGRICULTURE

Coordination is continuing with the irrigation portion of the study. As data come in, economic conditions will be varied to see what changes in repayment capacity result. Progress on this task is reported in the Task 4 section of this report.

INDUSTRY

With the cooperation of DNRC's Water Rights Bureau, investigation has begun to determine industrial willingness to pay for water. Based on a small sample of industrial applications for beneficial water use, it appears that some potential industrial water users would be willing to pay a great deal more than farmers would be able to pay. Little reliance should be placed on this generalization, however, until figures are put on an annual value basis. This analysis will be completed during the next quarter.

NEXT QUARTER'S ACTIVITIES

It is hoped that enough impact information will be available from field investigators early in the next quarter to allow economic impact analysis to appear in the March 1976 quarterly report.

This task is approximately 45% complete.

TASK 12. EVALUATION OF WATER MODEL. The Grantee shall provide an evaluation of the utility of the water modeling method used pursuant to this grant, with attention to its potential utility as a prototype in the Old West region of Montana, Wyoming, North Dakota, South Dakota, and Nebraska.

No work has been done on this task, and none is anticipated until Task 9 is further along.

FINANCIAL INFORMATION

Thru December 31, 1975

	Quarter	Total
Salaries	29,045.14	110,560.44
Wages	2,038.98	5,509.21
Benefits	3,874.13	13,888.21
Total Personal Services	34,958.25	129,957.86
Contract Services	32,586.77	95,536.21
Supplies & Materials	304.08	4,028.02
Communications	180.72	1,356.18
Travel	2,655.18	13,176.19
Rent	486.30	1,759.40
Repair & Maintenance	5.50	138.35
Other Expenses		1,221.72
Total Operating Expenses	36,218.55	117,216.07
TOTAL DIRECT EXPENSES	71,176.80	247,173.93
INDIRECT COSTS (5.77%)	4,106.90	14,261.94
TOTAL COSTS TO DATE	75,283.70	261,435.87
Funds on Hand 12-31-75		24,530.13
Estimated Funds needed for quarter ending March 31, 1976		
Salaries, wages & benefits		35,220.00
Contracted services		27,670.00
Supplies & materials		1,260.00
Communications & transportation		360.00
Travel		2,840.00
Other		1,400.00
	TOTAL	68,750.00

DETAIL OF CONTRACT PAYMENTS

	Quarter	Total
Dept. of Health:		
Personal Services		22,868.63
Supplies & Materials		2,904.21
Travel		1,926.79
Other Expenses		14.40
Total	-0-	27,714.03
Dept. of Fish and Game:		
Personal Services	17,907.88	37,326.59
Contracted Services	346.55	376.30
Supplies & Materials	1,998.07	2,714.93
Communications	257.64	331.41
Travel	3,924.14	7,444.34
Aircraft Rental	1,771.24	5,191.40
Utilities		4.80
Repairs & Maintenance	670.72	905.94
Other Expenses		1.60
Total	26,876.24	54,297.31
University of Montana:		
Personal Services	1,855.62	2,905.60
Supplies & Materials	156.40	174.53
Travel	185.65	185.65
Other Expenses	5.60	5.60
Total	2,203.27	3,271.38
Satish Nayak, Computer Systems Analyst	-0-	4,215.60

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